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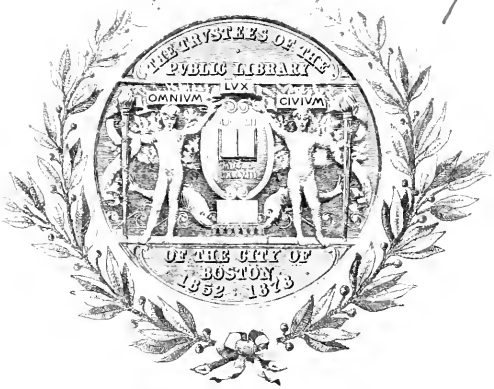

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ENGINEERING DEPARTMENT.

TWENTY-EIGHTH ANNUAL REPORT

OF THE

CITY ENGINEER,

BOSTON,

FOR THE YEAR 1894.

Printed for the Department.

BOSTON:
ROCKWELL AND CHURCHILL, CITY PRINTERS.
1895.

ENGINEERING DEPARTMENT, CITY HALL,

BOSTON, February 1, 1895.

HON. EDWIN U. CURTIS,

Mayor of the City of Boston:

SIR: In compliance with the Revised Ordinances the following report of the expenses and operations of the department for the year ending January 31, 1895, is submitted:

The report of this department may be classified under the following heads:

A. — The examination and supervision of structural repairs of bridges, the designing and superintending the construction of new bridges, retaining walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council.

B. — Charge of the engineering work in connection with the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works.

C. — Charge of the construction of a system of intercepting and outlet sewers.

D. — Charge of the engineering work in connection with the parks.

E. — Charge of the engineering work, except for Sewer Division, in connection with the Street Department.

The expenses incurred under the head "C" are paid wholly from a special appropriation.

A.

The following is a statement of engineering expenses from February 1, 1894, to January 31, 1895:

Amount of department appropriation for 1894–5	$35,000 00
Transferred from reserved fund	1,300 00
	$36,300 00
Amount expended from department appropriation for 1894–95	36,299 60
Unexpended balance	$0 40

STATEMENT OF EXPENDITURES, DEPARTMENT APPROPRIATION.

Object of expenditures:

Salaries of City Engineer, assistants, draughtsmen, transitmen, levellers, rodmen, etc.	$31,425 06
Engineering instruments and repairs of same	329 81
Drawing-paper, and all materials for making plans	482 55
Stationery, printing-stock, note-books, postage, etc.	381 35
Printing	230 76
Reference library, binding books, and photographs of works	482 80
Expenses of Charlestown Bridge Committee,	1,300 00
Travelling expenses (including horse-keeping, repairs on vehicles, etc.)	880 28
Telephone service	186 00
Furniture cases for plans and books, etc.	128 11
Blue-process printing	147 82
Incidental expenses, and all other small supplies	325 06
Total	$36,299 60

ABOLISHMENT OF GRADE CROSSINGS.

DOVER-STREET BRIDGE.

Expenditures from February 1, 1894, to February 1, 1895.

Steel superstructure (D. H. Andrews)	$38,098 72
Draw foundation and fender pier (J. P. Emond and P. F. McDonald)	25,583 00
Roadway paving and sidewalks (James Grant & Co.)	7,381 35
Engineering	1,965 75
Fender guard (Alex. McInnis)	1,585 00
Inspection of masonry, piling, and erection of steel superstructure	1,498 59
Fences (D. H. Andrews)	1,340 36
Draw-turning gear and brakes	1,317 80
Gates for draw (P. J. Dinn)	1,060 00
Labor on draw-pier, pulling piles, draw-house floor, labor on wharf, etc. (Nay & Ellis)	933 30
Draw-tender	788 25
Electric motor for draw	744 00
Lumber, etc., for pier	717 00
Draw-landing and wedges	682 24
Granite stones for piers (J. E. Lambert)	480 00
Rent (Blacker & Shepards, wharf for passageway)	480 00
Passageway for foot travel (labor and stock, Thomas Keyes)	392 21
Electric lighting	359 99
Building fences, gates, stairs, covering water-pipe, water-closet draw-tender's house (Thomas Keyes)	320 69
Machinery for draw	197 00
Iron-work	123 12
Stairs on pier (Thomas Keyes)	114 10
Plumbing water-closet (D. J. Kinnally)	107 10
Advertising	104 87
Printing	96 25
Pavement (James Grant & Co.)	91 50
Labor, etc., on dolphin (B. F. Nay & Co.),	43 28
Borings (B. F. Smith & Bro.)	35 00
Iron-work (Miller & Shaw)	27 65
Teaming (F. E. Whitcomb)	8 00
	$86,676 12
Expended previous to February 1, 1894	42,914 03
	$129,590 15

ALLSTON BRIDGE.

Appropriation, City of Boston,	$90,000 00	
Appropriation, Boston & Albany R.R. Co. . .	40,000 00	
		$130,000 00

Items of Expenditure from February 1, 1894, to February 1, 1895.

William Decoster (land damages)	$4,500 00	
Josiah Rhodes (labor) . .	8 23	
	$4,508 23	
Expended previous to February 1, 1894 . . .	85,403 94	
		$89,912 17
Total appropriation and revenue . .		$130,330 18
Expended by city of Boston .	$89,912 17	
" " Boston & Albany R.R. Co. .	40,000 00	
		129,912 17
Balance transferred to Street Improvement, Ward 25		$418 01

FRANKLIN-STREET TUNNEL, BRIGHTON.

Appropriations	$12,396 56

Items of Expenditure from June, 1894, to February 1, 1895.

Jones & Meehan (contractors),	$10,539 93	
Boston & Albany R.R. Co. (supporting tracks, and flagmen)	869 14	
Inspection	421 50	
E. B. Badger & Sons (copper gutters)	250 00	
Simpson Brothers (stone walk)	231 80	
Printing and stock . .	32 40	
Advertising	27 20	
Wooden fencing . . .	24 59	
		$12,396 56

STATUES.

Robert G. Shaw Monument.

Appropriation, Robert G. Shaw monument,		$19,500 00
Items of expenditure:		
Norcross Brothers, second estimate on base and pedestal	$5,440 00	
Expended previous to February 1, 1894	6,448 40	
		11,928 40
Balance February 1, 1895		$7,571 60

John Boyle O'Reilly Monument.

Appropriation, from Phillips Street-Fund, Income		$3,500 00
Items of expenditure:		
Foundation (Perkins & White)	$375 00	
Curbing, cut granite (Cape Ann Granite Company)	625 00	
		1,000 00
Balance February 1, 1895		$2,500 00

REBUILDING BRIDGES TO WATERTOWN.

Appropriation, Western avenue and North Beacon street		$18,000 00
Transferred August 1, 1894, to Franklin-street tunnel, Brighton		1,500 00
		$16,500 00

Items of Expenditure, February 1, 1894, to February 1, 1895.

Commonwealth of Massachusetts:		
Displacement of tide-water	$10 31	
Expended previous to February 1, 1894	10,973 33	
		10,983 64
Balance February 1, 1895		$5,516 36

IMPROVED SEWERAGE.

Total appropriations	$6,375,404 96

Statement of Expenses from February 1, 1894, to February 1, 1895.

Object of expenditure:		
General office expenses		$6,451 22
East Shaft, roadway		639 00
Miscellaneous		327 76
Section 6, Dorchester Intercepting Sewer .		455 36
" 7, " " " .		20,034 83
" 8, " " " .		471 35
" 9, " " " .		37,532 04
" 3, Outfall Sewer		17,603 18
" 3C, " "		15,603 17
		$99,117 91
Loans negotiated (less $67,500 transferred) . .	$6,308,664 03	
Revenue	66,740 93	
Total		$6,375,404 96
Expended previous to February 1, 1894 . .	$6,208,637 05	
Expended from February 1, 1894, to February 1, 1895,	99,117 91	
		6,307,754 96
Balance February 1, 1895 . . .		$67,650 00

IMPROVED SEWERAGE CONSTRUCTION, 1894.

Tables showing the cost of the sewer sections in progress during the year 1894, and other miscellaneous work.

General Office Expenses.

Items of expenditure:	
Salaries	$4,807 90
Office rent	821 33
Travelling expenses	291 15
Telephone service	150 30
Sundry small supplies	119 69
Engineering instruments and repairs . .	81 45
Drawing-paper and materials for plans .	75 02
Carried forward,	$6,346 84

Brought forward,	$6,346 84
Rubber clothing	39 28
Blue-process printing	37 19
Printing	19 28
Stationery and printing-stock	8 63
Total	$6,451 22

EAST SHAFT, ROADWAY.

Items of expenditure:	
Inspection	$179 00
Labor (Perkins & White)	460 00
	$639 00
Expended previous to 1894	4,458 54
Total	$5,097 54

MISCELLANEOUS.

Items of expenditure:	
New York & New England Railroad (Damages to abutments at Dorchester-avenue crossing)	$327 76
Expended previous to 1894	37 76
Total	$365 52

SECTION 3, OUTFALL SEWER.

Items of expenditure:		
Land damages:		
Lillie B. Titus	$15,603 18	
Henry W. Hunt	2,000 00	
		$17,603 18
Expended previous to 1894		112,077 28
Total		$129,680 46

SECTION 3C, OUTFALL SEWER.

Items of expenditure:	
Land damages:	
Lillie B. Titus	$15,603 17
Expended previous to 1894	95,245 90
Total	$110,849 07

SECTION 6, DORCHESTER INTERCEPTING SEWER.

Items of expenditure:	
Gravel	$34 36
Labor	109 75
Land damages:	
First Baptist Church Society of Dorchester	300 00
Miscellaneous	11 25
	$455 36
Expended previous to 1894	45,126 40
Total	$45,581 76

SECTION 7, DORCHESTER INTERCEPTING SEWER.

Items of expenditure:	
Bricks	$2,304 40
Cement	812 28
Coal	748 11
Drain-pipe	183 14
General supplies	271 32
Granite stones	53 00
Hardware	239 21
Labor	11,262 15
Lumber	579 26
Masonry walls (Davenport brook)	1,214 50
Miscellaneous	386 21
Piles, and labor on same	450 00
Rent of machinery	627 07
Rubber clothing	99 75
Sand and gravel	612 52
Teaming	191 91
	$20,034 83
Expended previous to 1894	17,369 06
Total	$37,403 89

SECTION 8, DORCHESTER INTERCEPTING SEWER.

Items of expenditure:	
Cement	$150 00
Drain-pipe	37 50
Carried forward,	$187 50

Brought forward,	$187 50
Granite stones	89 00
Gravel	100 00
Hardware	94 85
	$471 35
Expended previous to 1894	39,077 59
Total	$39,548 94

SECTION 9, DORCHESTER INTERCEPTING SEWER.

Items of expenditure:	
Bricks	$5,224 08
Car-fares	8 00
Cement	3,103 25
Coal	393 14
Drain-pipe	481 78
General supplies	692 03
Hardware	465 07
Insurance	260 00
Labor	17,418 16
Lumber	1,706 40
Piles, and labor on same	4,409 35
Rent of land	60 00
Rubber clothing	187 55
Sand and gravel	2,218 98
Teaming	904 25
	$37,532 04
Expended previous to 1894	53 71
Total	$37,585 75

BRIDGES.

The inspection of the highway bridges for the annual report of their safety and completeness has been made, and as usual, besides the highway bridges, all such bridges as the Public Garden foot-bridge and the bridges in the parks have also been inspected.

The widths of all openings in bridges for the passage of the vessels have been measured as usual.

In the list, those marked with a star (*) are over navigable water, and are each provided with a draw.

Twelve bridges have been added to the list as printed last year. These are park and parkway bridges which have

been built within two years, and not before added. Cottage Farm bridge, formerly maintained by the Boston & Albany Railroad Company, is now maintained by the city.

I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Agassiz bridge, in Back Bay Fens.
Allston, over Boston & Albany Railroad, Ward 25.
Arborway bridge, over Stony brook.
Ashland street, over Providence Division, N.Y., N.H., & H. R.R., Ward 23.
Athens street, over New York & New England Railroad.
Audubon road, over Boston & Albany Railroad.
Beacon Entrance, Back Bay Fens, over Boston & Albany Railroad.
Beacon street, over outlet to Back Bay Fens.
Beacon street, over Boston & Albany Railroad.
Berkeley street, over Boston & Albany Railroad.
Berkeley street over Providence Division, N.Y., N.H., & H. R.R.
Bernier street foot-bridge (in the Riverway).
Bernier street foot-bridge (over Muddy river).
Berwick Park foot-bridge, over Providence Division, N.Y., N.H., & H. R.R.
Blakemore street, over Providence Division, N.Y., N.H., & H. R.R.
Bolton street, over New York & New England Railroad.
Boylston street, in Back Bay Fens.
Boylston street, over Boston & Albany Railroad.
Bridle Path in the Riverway, over Muddy river.
*Broadway, over Fort Point channel.
Broadway, over Boston & Albany Railroad.
Brookline avenue, over Boston & Albany Railroad.
Byron street, over Boston, Revere Beach, & Lynn Railroad.
*Castle island foot-bridge, from Marine park, South Boston, to Castle island.
*Charles river, from Boston to Charlestown.
*Chelsea (South), over South channel of Mystic river.
*Chelsea street, from East Boston to Chelsea.
Columbus avenue, over Boston & Albany Railroad.
Commonwealth avenue, in Back Bay Fens.
*Commercial point, or Tenean, Ward 24.
*Congress street, over Fort Point channel.
Cottage Farm, Brighton.
Cottage-street foot-bridge, over flats, East Boston.
Cornwall street, over Stony brook, Ward 23.

Circuit Drive, over Scarboro' pond in Franklin park.

Dartmouth street, over Boston & Albany Railroad and Providence Division, N.Y., N.H., & H. R.R.

*Dover street, over Fort Point channel.

Ellicott arch, in Franklin park.

*Federal street, over Fort Point channel.

Fen bridge, Back Bay Fens.

Ferdinand street, over Boston & Albany Railroad.

Forest Hills entrance, in Franklin park.

Gold street foot-bridge, over New York & New England Railroad.

Huntington avenue, over Boston & Albany Railroad.

Irvington-street foot-bridge, over Providence Division, N.Y., N.H. & H. R.R.

*L street, over Reserved channel, South Boston flats.

Leverett pond foot-bridge, in Leverett park.

Leyden street, over Boston, Revere Beach, & Lynn Railroad.

Linden Park street, over Stony brook.

*Malden, from Charlestown to Everett.

Massachusetts avenue (formerly West Chester Park), over Boston & Albany Railroad.

Massachusetts avenue (formerly West Chester Park), over New York, New Haven, & Hartford Railroad.

*Meridian street, from East Boston to Chelsea.

*Mount Washington, over Fort Point channel.

Neptune road, over Boston, Revere Beach, & Lynn Railroad.

Newton street, over Providence Division, N.Y., N.H., & H. R.R.

Public Garden foot-bridge.

Scarboro' pond foot-bridge (in Franklin Park).

Shawmut avenue, over Boston & Albany Railroad.

Stony brook, Back Bay Fens.

Swett street, east of New York & New England Railroad.

Swett street, west of New York & New England Railroad.

*Warren, Boston to Charlestown.

West Rutland square foot-bridge, over Providence Division, N.Y., N.H., & H. R.R.

Winthrop, from Breed's Island to Winthrop.

II.—BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

Bellevue street, in the Riverway, over Muddy river.

Brookline avenue, in the Riverway, over Muddy river.

*Cambridge street, from Brighton to Cambridge.

Central avenue, from Ward 24 to Milton.
*Chelsea (north), from Charlestown to Chelsea.
*Essex street, from Ward 25 (Brighton) to Cambridge.
Foot-bridge near Bernier street, in the Riverway, over Muddy river.
*Granite, from Dorchester, Ward 24, to Milton.
Longwood avenue, from Ward 24, to Brookline.
Mattapan, from Ward 24 to Milton.
Milton, from Ward 24 to Milton.
*Neponset, from Ward 24 to Quincy.
*North Beacon street, from Brighton to Watertown.
*North Harvard street, from Brighton to Cambridge.
Spring street, from West Roxbury to Dedham.
Tremont street, in the Riverway, over Muddy river.
*Western avenue, from Brighton to Cambridge.
*Western avenue, from Brighton to Watertown.

III.— BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

Albany street, over Boston & Albany Railroad.
*Canal, from Boston to Cambridge.
Dorchester street, over Old Colony Division, N.Y., N.H., & H. R.R.
Everett street, over Boston & Albany Railroad, Ward 25.
*Harvard, from Boston to Cambridge.
*Prison Point, Charlestown to Cambridge.
*West Boston, from Boston to Cambridge.

IV.— BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

1st. — Boston & Albany Railroad.

Harrison avenue.
Market street, Brighton.
Tremont street.
Washington street.

2d. — Boston & Maine Railroad, Western Division.

Mystic avenue.
Main street.

3d. — Boston & Maine, Eastern Division.

Mystic avenue.
Main street.

4th. — Boston, Revere Beach, & Lynn Railroad.

Everett street.

5th. — New York & New England Railroad.

Broadway.
Dorchester avenue.
Fifth street.
Morton street, Ward 24.
Fourth street.
Harvard street, Ward 24.
Norfolk street, Ward 24.
Norfolk street, Ward 24.
Second street.
Silver street.
Sixth street.
Third street.
Washington street, Ward 24.

6th. — New York, New Haven, & Hartford Railroad, Old Colony Division.

Adams street.
Ashmont street and Dorchester avenue.
Cedar Grove cemetery.
Commercial street.
Savin Hill avenue.

7th. — N. Y., N. H., & H. R. R., Providence Division.

Beech street, Ward 23.
Bellevue street, Ward 23.
Canterbury street, Ward 23.
Centre street, or Hog bridge.
Centre and Mt. Vernon streets.
Dudley avenue.
Park street.

Recapitulation of Bridges.

I.	Number wholly supported by Boston . .	65
II.	Number of which Boston supports that part within its limits	18
III.	Number of which Boston pays a part of the cost of maintenance	7
IV.	Number supported by railroad corporations :	
1.	Boston & Albany	4

2.	Boston & Maine, Western Division . .	2
3.	" " Eastern Division . .	2
4.	Boston, Revere Beach, & Lynn Railroad .	1
5.	New York & New England Railroad . .	13
6.	N.Y., N.H., & H. R.R., Old Colony Division,	5
7.	" " Providence Division,	7
	Total number	124

Agassiz-road Bridge (in Back Bay Fens).

This bridge was built in 1887, of brick and stone masonry. It is maintained by the Park Department and is in good condition. The settlement of the surrounding filled territory leaves the bridge high, and causes cracks to open in the joints of the edgestone and parapet, but does not in any way affect the strength of the bridge.

Albany-street Bridge (over the Boston & Albany R.R.).

This is an iron bridge; the present structure was built in 1886–87. It is maintained in part by the city of Boston and in part by the Boston & Albany Railroad Company. The iron-work above the floor was painted one coat in 1891, but below the floor no painting has been done since the bridge was erected: the lower portion is therefore very rusty and should be painted the coming season. There are two wire guys attached to the top chord of the bridge which should be removed.

Allston Bridge (over the Boston & Albany R.R., Ward 25).

This is an iron bridge built in 1892; it is in good condition, but will need painting next year.

Arborway Bridge (over Stony Brook, in Parkway, near Forest Hills Station).

This is a wooden bridge resting on abutments of vulcanized spruce piles. The stringers and under planking are of vulcanized hard-pine. It was built in 1893, and is maintained by the Park Department.

Ashland-street Bridge (over Providence Division, N.Y., N.H., & H. R.R., Ward 23).

The present structure is of iron, and was built in 1875. The iron-work is in good condition. The wooden fences are very old and unsightly.

Athens-street Bridge (over New York & New England R.R.).

This is an iron bridge, built in 1874. It should be painted.

Audubon-road Bridge (over the Boston & Albany R.R.).

This bridge was built in 1893, with the exception of the sidewalk flooring and the iron railings; these were put in last year, and the bridge is now ready for use. It has not, however, been opened to travel, owing to the unfinished condition of the approaches. The railings were erected by the Boston Bridge Works, under an agreement dated April 9, 1894, and the wooden flooring was put on by Thomas Keyes, under an agreement dated April 16, 1894.

Beacon entrance (in Back Bay Fens, over Boston & Albany R.R.).

This is an iron bridge, and was built in 1881–82. It is maintained by the Park Department. There are signs of cars scraping the under side of the bridge, and it is known that the bridge has settled badly on account of the compression of the mud under the filling. Otherwise it is in good condition. The bridge will be raised during the coming season.

Beacon-street Bridge (over Outlet of Back Bay).

This is an iron bridge, built in 1880–81. It is in fair condition.

Beacon-street Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1884–85, widened in 1887–88, and the central roadway further widened in 1890 for the convenience and at the expense of the West End Street Railway Company. The portion above the floor needs painting; otherwise the bridge is in good condition.

Bellevue-street Bridge (over Muddy River, in the Parkway).

This is a segmental masonry arch of 44 ft. span and 15 ft. rise. The foundation is of concrete, the face walls of seam-faced granite, and the arch of brick. It was built in 1893, by the Park Departments of Boston and Brookline, and is maintained jointly by them.

Bernier-street Foot-bridge (over Bridle Path, in Riverway).

This is a semicircular masonry arch of 38 feet 4 inches span. The foundations are of concrete, the exposed face walls of seam-faced granite, and the arch is of brick, the face brick being buff-colored. It was built in 1893, and is maintained by the Park Department.

Bernier-street Foot-bridge (over Muddy River).

This is a segmental masonry arch of 52 feet span and 14 feet rise. The foundations are of concrete, the exposed face walls are of seam-faced granite, and the arches of brick. It was built in 1893 by the Park Departments of Boston and Brookline, and is maintained jointly by them.

Berkeley-street Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1891, and is now in good condition. The iron railing which was put up in 1892, and apparently needed, received but a single coat of paint. It should be painted again, as it begins to show signs of rust. The temporary railing at the north-easterly corner of the bridge should be replaced by a more permanent fence. The abutments have been repointed and are now in a fair condition.

Berkeley-street Bridge (over Providence Division, N.Y., N.H., & H. R.R.).

This bridge has been reported for a number of years to be in bad condition, and only such repairs as seemed absolutely necessary have been made. During the past year one of the columns supporting the sidewalk was knocked down by a freight car. Fortunately no serious damage was done. It serves to show, however, that at any time the bridge is liable to be thrown down, and that serious damages may result. The railroad company have for many years desired to have this structure replaced by one with stone piers instead of iron columns, and it is recommended that negotiations be entered into with the railroad company looking to the building of a proper bridge at this point, before it becomes necessary to put a new floor on the present structure, which cannot be delayed more than a year or two longer.

Berwick-park Foot-bridge (over Providence Division, N.Y., N.H., & H. R.R.).

(See page 31.)

Blakemore-street Bridge (over Providence Division, N. Y., N.H., & H. R.R.).

This is an iron bridge. It was built in 1881–82, and is in good condition.

Bolton-street Bridge (over New York & New England R.R.).

This is a wooden bridge, built in 1889. The fences should be painted and sanded.

Boylston-street Arch Bridge (in Back Bay Fens).

This is a stone arch bridge, built in 1881. It is in good condition except that there are open joints in the parapet caused by the settlement of the adjoining filled land. These joints should be repointed.

Boylston-street Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1886–88. The iron-work below the floor has never been painted since the bridge was erected. It is now in a very rusty condition, and the recommendations made to the Street Department in October last are here renewed, that the wood-work be stripped off and the iron thoroughly cleaned and painted. At the time the bridge was built, only a temporary wooden fence was put up. During the past year an iron railing has been erected by the Boston Bridge Works, at a cost of $1,094. The abutments and adjoining retaining-walls are in good condition.

Broadway Bridge (over Fort Point Channel).

This is an iron bridge. It was built in 1869–71, and the draw and its foundation were rebuilt in 1874–75. The bridge was temporarily strengthened so as to allow electric cars to use it in 1893. The draw and draw foundations are in good condition and present a creditable appearance; the remaining parts of the bridge are old and patched and should be rebuilt. No repairs of importance have been made during the year.

Broadway Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1880–81. The location of this bridge over the railroad tracks leading to the round-houses is such that locomotives are standing beneath it a large part of the day; for this reason the iron-work below the floor requires frequent painting. Although this bridge

was painted in 1892 with a single coat of red-lead, the coming season should not be allowed to pass without the under part being again cleaned and painted. The fence of the bridge is in poor condition, and should be repaired, portions of the lower rail being entirely rusted away. This bridge presents a good example of the evil of allowing guy-lines to be attached to bridges. A long guy from a telephone pole has been secured to the top of one of the end posts, and the post selected is the one which, owing to the sharp skew of the bridge, receives the least support from the portal bracing. If the wire on one side of this pole should be cut or broken from any cause, the strain brought on this particular end post by the guy might be sufficient to seriously injure the bridge. Permits should not be given to attach guys to bridges, and where already given they should be revoked.

Bridle-path Bridge, in the Riverway (over Muddy River).

(See page 107.)

Brookline-avenue Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1884. This bridge has been cleaned and painted and a new flooring put in. It is now in good condition. There is a guy attached to one of the top chords of this bridge, and as the truss has no top lateral bracing there is nothing to prevent the chord being thrown out of alignment.

Brookline-avenue Bridge (over Muddy River, in the Riverway).

This is a semicircular masonry arch of 15 feet span. The abutments and face walls are of granite, resting on a pile and timber foundation. The face walls are of seam-faced granite. The arch is of brick. It was built in 1892 by the Park Departments of Boston and Brookline, and is maintained by them jointly.

Byron-street Bridge (over Boston, Revere Beach, & Lynn R.R.).

This is a wooden bridge, built in 1889. The nests built under the bridge by the English sparrows should be removed, as the bridge is likely to be set on fire by sparks from the locomotive. The bridge is in good condition.

Cambridge-street Bridge (from Brighton to Cambridge).

This is a wooden pile bridge with a wooden leaf draw. The city maintains the part within its limits. It was rebuilt in 1884; the draw was rebuilt in 1891. Electric cars now run over the bridge. The draw-pier is too short to accommodate the larger class of vessels that the widening of the draw-way allows to pass through the bridge; otherwise the bridge is in good condition.

Canal or Craigie's Bridge.

This is a wooden pile bridge, with wooden turntable draw. The city pays one-half of the cost of maintenance. The bridge was originally built in 1808, was rebuilt in 1852, and again rebuilt and widened in 1874. The bridge is in the care of a commission, consisting of one commissioner from Boston and one from Cambridge. The sides of the waterway for the passage of vessels through the bridge have been planked with 3-inch spruce. A bulkhead near the draw has been rebuilt. A weak point near the Cambridge end of the bridge has been strengthened, fences have been repaired, the draw sheathed, sidewalks repaired, and other ordinary repairs made by the aid of the men employed on the bridge. The flooring of the sidewalks near the Cambridge end and the bulkhead are in bad condition, and will be rebuilt next season.

Castle Island Foot-bridge (from Marine Park to Castle Island).

This is a temporary foot-bridge, built in 1892. It connects the Marine park with Castle island, and is furnished with a draw, so that, if desired by the United States authorities, the island can be cut off from the shore. It is now in good condition.

Central-avenue Bridge (over Neponset River, Dorchester Lower Mills).

This is an iron bridge, and was built in 1876. The city maintains the part within its limits. The bridge should be stripped and painted, the wood-work renewed, and the abutment pointed.

Charles-river Bridge (from Boston to Charlestown).

This is a wooden pile bridge with an iron draw. The present bridge was built in 1854–55; the draw was built in 1870. The bridge has been strengthened in order to make

it safe for light team travel, the brick sidewalks have been put in good condition, and the fence and buildings have been painted. The draw and draw foundation are old and poor, and estimates have been made for strengthening the same: the easterly draw-pier is too short for the vessels now using it, and the end of the pier is in a dangerous condition.

Chelsea Bridge North (from Charlestown to Chelsea).

The Boston & Maine Railroad will reconstruct this bridge within about one hundred feet of the draw, changing the grade in connection with the work of abolishing the grade crossings on the Mystic wharves. This will leave practically nothing of the part of the present bridge but the draw. The draw is a wooden structure, built in 1873. It is the oldest wooden draw in the city, and is in such condition from old age and decay that it may be disabled at any time. The samson posts are decayed and settled at the base, and are also rotten at the tops. The cross-bracing between the tops is decayed, and the outer trussed beams of the bridge itself are also in bad condition from decay. The draw is in constant use by electrics, and is warped and settled so that the roadway presents a very weak appearance.

It is a worn-out structure and is in a dangerous condition. The work of the railroad will be done in such a manner that team travel between Charlestown and Chelsea over this bridge will be stopped for a considerable time, beginning about the first of May, 1895. Foot-passengers and electrics will continue to use the draw, but provision can be made for electrics by an extension of the temporary bridge now in use, and the entire work of replacing the draw can be done at this time with a minimum of expense and inconvenience to the City, the Boston & Lynn Railroad, the Boston & Maine Railroad, and the general public. If so built, the entire structure from Charlestown to the Chelsea line will have been renewed at one time, and should require no further renewals or repairs to the great inconvenience of the public for the next twenty years.

Chelsea Bridge, South (over South Channel, Mystic River).

This is a pile bridge, with an iron draw. The original bridge was built in 1802–3, and the present structure in 1876–77. The work of rebuilding this bridge and raising the grade for the purpose of abolishing the grade crossings on the tracks of the Boston & Maine Railroad has been commenced. The work is in charge of the railroad.

At present the bridge is in safe condition, and only absolutely necessary repairs have been made upon it during the last year.

Chelsea-street Bridge (from East Boston to Chelsea).

This is a new pile bridge, with a new iron swing draw, and was rebuilt last year. The original bridge was built in 1834; was rebuilt in 1848, and again in 1873, except the draw, which was built in 1868. (See page 38.)

Circuit-drive Bridge (over Scarboro' Pond, in Franklin Park).

This is an elliptical masonry arch of 30 feet span and 6 feet 3 inches rise. The abutments are of granite ashlar backed by concrete; the face walls are of seam-faced granite and the arch is of brick. It was built in 1893, and is maintained by the Park Department.

Columbus-avenue Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1876–77. The iron-work below the floor is somewhat rusty, otherwise the bridge is in good condition. As reported last year, "it is still made an anchorage for telegraph-pole guys," which should be removed.

Commercial Point or Tenean Bridge (Ward 24).

This is a wooden pile bridge, with a wooden leaf draw. The present bridge was built in 1875. The fences and draw are in poor condition and should be rebuilt at once, and the bridge floor should be renewed. Fences have been painted.

Commonwealth-avenue Bridge (in Back Bay Fens).

This is an iron bridge. It was built in 1881–82. The sidewalks have been planked. It is in good condition.

Congress-street Bridge (over Fort Point Channel).

This is a wooden pile bridge, with an iron turntable draw on a stone foundation, and was built in 1874–75. The under floor of the bridge should be thoroughly repaired. It should be uncovered so that its condition can be ascertained, and it is probable that it will require an entirely new floor under the sidewalk and roadway. The upper part of the pier should also be uncovered and examined, and will probably need extensive repairs. The landings of the draw need re-

building. The sidewalk, bulkhead, and fencing is poor and several of the piles are rotten at the top. The centre pivot of the draw was examined last summer and found to be in good order. The track, wheels, and other portions of the turntable are badly worn and require constant attention. Extensive repairs are needed to put the draw in condition to meet the heavy service it is called upon to perform. The engines have been overhauled and two new steel boilers have been put in during the year. The wood-work at the ends of the draw is badly split and should be repaired.

Cornwall-street Bridge (over Stony Brook, Ward 23).

This is a small wooden bridge, built in 1892. It is in good condition, except that the outlets for water are insufficient, the bridge being at the foot of the grade at either end.

Cottage Farm Bridge, Brighton.

(See page 39.)

Cottage-street Foot-bridge (over Flats, East Boston).

This is a wooden pile bridge, built in 1889 for foot travel only. The crossbracing, which was broken off by the ice, has been replaced; some of the planking has been renewed, and the bridge is in good condition.

Dartmouth-street Bridge (over B. & A. R.R. and Providence Division, N.Y., N.H., & H. R.R.).

This is an iron bridge, built in 1878–79. It is in good condition excepting the wooden boxing around the ends of the floor-beams. This is in bad shape, in some places having entirely fallen off, and in others being in a very dilapidated condition. The network of wires which have been placed on this bridge disfigure it badly and should be removed.

Dorchester-street Bridge (over Old Colony Division, N.Y., N.H., & H. R.R.).

This is an iron bridge, built in 1869. It is principally maintained by the railroad company, and was repaired in 1893 as thoroughly as it could be without building new girders.

Dover-street Bridge (over Fort Point Channel).

(See page 40.)

Ellicott-arch Bridge (in Franklin Park).

This is a semicircular masonry arch of 17 feet 6 inches span. It was built in 1889, and is maintained by the Park Department.

Essex-street Bridge (from Brighton to Cambridge).

The city maintains the part within its limits. This is a wooden pile bridge, with a wooden leaf draw, and was originally built in 1850; the draw was rebuilt in 1891. This is an old bridge and is in poor condition. Steps have been taken by the City Council, in connection with the city of Cambridge, looking toward building a new bridge in another location. Meanwhile this bridge should be watched and kept in safe condition.

Everett-street Bridge (over B. & A. R.R., Ward 25).

This is an iron bridge, built in 1891, by the Boston & Albany Railroad. It is in good condition.

Federal-street Bridge (over Fort Point Channel).

This is a wooden pile bridge, with a double iron draw, and was rebuilt in 1891–92. The upper part of the bridge should be painted and the damage to the gate by teams hauling snow should be made good. It is in good condition.

Fen Bridge (in Back Bay Fens).

This bridge was built in 1891–92. It is in good condition.

Ferdinand-street Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1892. It is in good condition. The fence on the north-west retaining-wall adjoining the bridge should be put in good order and painted. It was never properly repaired after the damage caused by the burning of the oil-house in the railroad yard.

Forest Hills-entrance Bridge (in Franklin Park).

(See page 113.)

Gold-street Foot-bridge (over New York & New England R.R.).

This is a wooden foot-bridge, built in 1890. An appropriation has been made for building a new bridge for team travel on this site.

Granite Bridge (from Ward 24 to Milton).

This is a wooden pile bridge with a wooden leaf draw. The city maintains the part within its limits. The bridge was originally built in 1837. The sidewalk plank will need attention; otherwise the bridge is in fair condition. Both draw-piers are maintained by the town of Milton, and the up-river pier has been rebuilt and lengthened.

Harvard Bridge (from Boston to Cambridge).

This is an iron bridge with an iron turntable draw, and was built in 1887–91. The bridge is in the care of two commissioners, one appointed from Boston and one from Cambridge, and the expense of maintenance is borne equally by each city. The roadway of the bridge for its entire length was sheathed in July, 1894. The surface of the sidewalk is badly cracked and should be repaired. As the contractors who put down the asphalt are under a guarantee to maintain these walks in a satisfactory condition for five years, it is recommended that they be called upon to make good their guarantee. With the exception of the fences, which were painted in 1893, no painting has been done to the iron-work of this bridge since its erection in 1889. Parts of the bridge are now badly rusted, and should be painted this year. If this work is done at once, the iron carefully cleaned of rust and thoroughly painted, it will be better for the bridge, and can be done much cheaper than if delayed for a year or two when the rust has eaten into the iron so deep that the strength of the structure is permanently reduced and the labor of cleaning greatly increased. The masonry piers and the wooden draw-pier are in good condition.

Huntington-avenue Bridge (over Boston & Albany R.R.).

This is an iron bridge. It was built in 1872, and in 1876–77 the abutments were rebuilt and the bridge widened by the addition of two new girders. The bridge is in fair condition, excepting the wooden fence, several of the posts of which are badly decayed. As it is proposed to regrade Huntington avenue this year, the recommendation made in this report for several years past should be carried out, and the surface of the bridge and its approaches made to conform.

Irvington-street Foot-bridge (over N. Y., N.H., & H. R.R.).

This is an iron foot-bridge, built in 1892. It is in good condition.

L-street Bridge (over Reserved Channel, South Boston).

This is a wooden pile bridge with an iron retractile draw. It was built in 1892. At the time of the last annual report the bridge had been opened to foot travel only. It was informally opened to team travel on June 4, 1894. It is in good condition.

Leverett-pond Foot-bridge (in Leverett Park).

(See page 109.)

Leyden-street Bridge (over Boston, Revere Beach, & Lynn R.R.).

This is an iron bridge, built in 1889. It is in fair condition.

Linden Park-street Bridge (over Stony Brook).

This is a wooden bridge, built in 1887. It is in fair condition.

Longwood-avenue Bridge (from Ward 22 to Brookline).

The city maintains the part within its limits. The present structure was built in 1877. It is a wooden bridge, on wooden posts set in the ground. The ground under the bridge has been regraded. The bridge is in poor condition. The construction of Riverdale park, which the bridge crosses, will hasten the removal of this bridge, which is only a temporary structure.

Malden Bridge (from Charlestown to Everett).

The present structure was built in 1875 and the draw in 1892. The bridge has been painted, the waterways repaired, and other small repairs made. The draw runs hard, and it should be adjusted. The fender-guard, fences, and sidewalk are in very poor condition; the draw-piers are old, weak, and are too short.

Massachusetts-avenue Bridge, formerly West Chester Park (over Providence Division, N. Y., N.H., & H. R.R.).

This is an iron bridge, built in 1876. It is in good condition.

Massachusetts-avenue Bridge, formerly West Chester Park (over Boston & Albany R.R.).

This is an iron bridge. It was built in 1876. It was thoroughly repaired in 1893 with the exception of the wooden fences; both fences are somewhat decayed, and that on the westerly side has been pulled out of line by a telegraph pole which is attached to the girder. On both sides of this bridge poles carrying about fifty wires have been erected on the girders; and as other means are available for supporting these wires, the bridge should be relieved of this unnecessary strain.

Mattapan Bridge (from Ward 24 to Milton).

The city maintains the part within its limits. This is an old iron bridge and is in a dangerous condition, and it should be replaced by a stone bridge. No repairs have been made except to patch the roadway plank.

Meridian-street Bridge (from East Boston to Chelsea).

This is a wooden pile bridge, with a wooden turntable draw on a pile foundation. The original structure was built in 1858. It was rebuilt soon afterwards, and was widened and rebuilt in 1884, excepting the draw, which was built in 1875–76. The draw is old for a wooden structure and requires constant care. The draw-piers are in poor condition; the concrete sidewalk needs repairs; the bridge has been painted and the water ways repaired. The electric cars began running over the bridge December 11, 1894.

Milton Bridge (from Ward 24 to Milton).

The city maintains the part within its limits. The original structure is very old. It was widened in 1871–72. The older part of this bridge was built of stone, and the widening is an iron structure on stone columns. No repairs have been made, and the bridge is in fair condition.

Mt. Washington-avenue Bridge (over Fort Point Channel).

This is a wooden pile bridge with an iron draw. It was built in 1854, and rebuilt in 1870–71. The draw-pier is in poor condition, and it is so low that it is covered with water at every high course of tides.

This is the only draw of importance in the city that is moved by hand power. The pavement is in poor condition, and the fender-guard is old and weak. The draw-ways and

ends of the pier have been repaired, and the bridge has been painted.

Neponset Bridge (from Ward 24 to Quincy).

The city maintains the part within its limits. The original structure was built in 1802, and the present one in 1877. The draw is too heavy to be handled by hand, and should be replaced by a turntable draw. The Boston end of the bridge has a new six-inch deck. The latches and piers need repairing and the iron draw needs painting.

Neptune-road Bridge (over Boston, Revere Beach, & Lynn R.R.).

This is an iron bridge, built in 1887–88, and is maintained by the Park Department. It has been painted and is in good condition.

Newton-street Bridge (over Providence Division, N.Y., N.H., & H. R.R.).

This is an iron bridge, built in 1872. It is in good condition, excepting the concrete sidewalks, which should be resurfaced.

North Beacon-street Bridge (from Brighton to Watertown).

The city maintains the part within its limits. This is a wooden pile bridge with a wooden leaf draw. The original structure was built in 1822, and the present one in 1884. No progress has been made toward rebuilding the draw so as to allow room for larger vessels to pass, for which purpose a partial appropriation has been made. The deck is in poor condition.

North Harvard-street Bridge (from Brighton to Cambridge).

The city maintains the part within its limits. This bridge was originally built in 1662, and was rebuilt in 1879. The draw was rebuilt in 1891. The fence on the bridge needs repairing, and the abutment is in poor condition, to which attention has been called in previous reports; otherwise the bridge is in good condition.

Prison Point Bridge (from Charlestown to Cambridge).

The city pays one-half of the cost of maintenance. This bridge was originally built in 1833, and the present structure was built in 1876–77. It is a wooden pile bridge, with an

iron leaf draw. The bridge is in the care of commissioners, consisting of one commissioner from Boston and one from Cambridge. It is in poor condition. The house occupied by the draw-tender has been papered and painted inside by the draw-tender. Only ordinary repairs, such as planking and sheathing, have been made on the bridge. The draw is in bad condition and needs a thorough repairing. The question of abolishing the grade crossing on the Boston & Maine Railroad, which adjoins the bridge, is under discussion. If this should be accomplished by carrying the highway over the railroad, it would involve the rebuilding of the bridge. For this reason only such repairs have been made as were absolutely necessary for safety.

Public Garden Foot-bridge.

This is an iron bridge. It was built in 1867, and was thoroughly repaired in 1887. In fair condition except the floor, which needs an entire renewal.

Scarboro' Pond Foot-bridge (in Franklin Park).

This is an elliptical masonry arch of 40 feet span and 8 feet 3 inches rise. The face-work is of quarried face Roxbury stone and the arch is of brick. It was built in 1893, and is maintained by the Park Department.

Shawmut-avenue Bridge (over Boston & Albany R.R.).

This is an iron bridge, built in 1871. The sidewalk on the westerly side of the bridge has been repaired and a new coal-tar surface put on. The girders under the walk have been painted. The whole under portion of this bridge, however, needs painting. The report of last year in regard to the unsightly bend in the ornamental parapet caused by the electric wire pole of the West End Street Railway Company still remains true.

Spring-street Bridge (from Ward 23 to Dedham).

This is a stone bridge. The city maintains the part within its limits. It is in good condition.

Stony-brook Bridge (Back Bay Fens).

This is an ornamental brick, arched bridge with stone facings, built in 1891–92. It is in good condition. It is maintained by the Park Department.

Swett-street Bridges (over South Bay Sluices).

These are wooden bridges, and were built in 1875. They are temporary structures and are in poor condition. The bulkheads that support the adjoining sluices are very much out of shape, and may require repairs at any time. The roadways of these bridges have been kept in safe condition, but as bridges they are of but little value.

Tremont-street Bridge (over Muddy River).

This is a semicircular masonry arch of 15 feet span. The foundation is of concrete, the abutments of granite ashlar backed with concrete. The side walls are of seam-faced granite, and the arch is of brick. It was built in 1893, and is maintained by the Park Departments of Boston and Brookline.

Warren Bridge (from Boston to Charlestown).

This is a wooden pile bridge, with a double iron draw. The present structure was built in 1883–84. The sidewalk on the down-stream side and at the entrance to Fitchburg Railroad yard, and the draw-piers and the block-stone pavements, are in poor condition. The ends of the draw need attention, and about sixty feet of the fence near the Causeway-street end of the bridge has been so damaged by teams dumping snow that it should be rebuilt. The bridge has been painted and ordinary repairs have been made.

Western-avenue Bridge (from Brighton to Cambridge).

The city maintains the part witin its limits. The present bridge was built in 1879–80, and the draw in 1891. The fences and some of the spur-shore piles are in poor condition. The draw-pier is too short. Only small repairs have been made.

Western-avenue Bridge (from Brighton to Watertown).

The city maintains the part within its limits. This is a wooden pile bridge, with an iron draw, and was rebuilt in 1892–93. It should be painted.

West Boston Bridge (from Boston to Cambridge).

This bridge is in the care of two commissioners, one from Boston and one from Cambridge. The city pays one-half of the cost of maintenance. This is a wooden pile bridge, with a wooden turntable draw. The bridge was originally

built in 1792–93, was rebuilt in 1854, and repaired in 1871. This is an old, weak bridge, but is kept in as good condition as possible. This bridge, with Canal and Prison Point bridges, is in the care of the same commission, and they are kept in usable condition only by the constant care and personal supervision given them by the commissioner from Cambridge. The under plank of the draw has been partly renewed, part of the waterway on side of the pier has been replanked, spur-shores and braces have been bolted and spiked to the piles to keep the bridge in line. The whole length of the bridge under the planking of the roadway has been examined, and strengthened where necessary. The bulkhead at the Boston end of the draw, which has been a source of trouble for some years, has been rebuilt. The work was done between 1 A.M. and 3 A.M., on Sunday, without interruption to travel. The ordinary repairs, such as sheathing the draw, repairing fences, renewing plank on piers, paving, etc., have been attended to. Much of this work has been done by the draw-tender and his assistants.

West Rutland-square Foot-bridge (over Providence Division, N. Y., N.H., & H. R.R.).

This is an iron foot-bridge, built in 1882. The stair-treads are badly worn and should be renewed. The sidewalks in Rutland square at the foot of the stairs are too low and should be regraded.

Winthrop Bridge (from Breed's Island to Winthrop).

This is a pile bridge, without a draw. It was originally built in 1839, it was rebuilt in 1851, and was extensively repaired in 1870. This bridge was damaged by ice during the winter and will require extensive repairs. Estimates have been made for making a solid causeway, with a culvert, in place of the bridge. This scheme is entirely feasible, and at a moderate cost.

Bridges wholly supported by Railroads.

The bridges over the Boston & Albany Railroad maintained by that company are in a good or fair condition, and require no special report, with the exception of the Washington-street bridge. In 1891 new girders were placed under the roadway, and this portion of the bridge is in good condition. It was thought at that time that the girders supporting the sidewalks, although badly rusted, would be safe for a few years more. Since that time the corrosion has con-

tinued so rapidly that now large areas of the web plates have disappeared from the girders located on the curb lines, and it is impossible to make a reasonable estimate of the strength of the remaining part. The load coming on the weakest of these girders has been increased the past year by the addition of a second line of gas-pipes. As this bridge is on one of the principal streets of the city, and liable at any time to have a crowd of people on the sidewalks, it cannot be considered in a safe condition. It is therefore recommended that the railroad company be notified to rebuild the sidewalk portions at once.

The remaining bridges require no special mention.

MISCELLANEOUS WORK AND CONSTRUCTION IN 1894.

BERWICK PARK FOOT-BRIDGE, OVER PROVIDENCE DIVISION, NEW YORK, NEW HAVEN, & HARTFORD RAILROAD.

Plans and specifications for a retaining-wall on Follen street, and additions to the present retaining-wall on Berwick park, were prepared, and on June 21 a contract for doing this was concluded with Quimby & Ferguson for the sum of $3,200. These retaining-walls form the supports of an iron foot-bridge similar to that over the railroad at Irvington street. The iron stairways and piers were furnished by the Boston Bridge Works, at a cost of $1,200. The iron span is that formerly used at Franklin street, Allston; it was taken down, moved, and erected at Berwick park by the Boston Bridge Works for the sum of $500.

BOYLSTON-STREET BRIDGE, OVER BOSTON & ALBANY RAILROAD.

Iron railings have been erected on this bridge, and on one of the street retaining-walls. The work was done by the Boston Bridge Works from plans and specifications prepared by this department.

CHARLES-RIVER BRIDGE.

This bridge, which was closed to team travel on account of its dangerous condition, has been temporarily strengthened for the passage of light teams and foot travel. Plans and specifications were prepared and a contract was made August 31, 1894, with Trumbull & Ryan for doing the work. The bents of piles where the bridge was out of line were stiffened by spur-shore piles and cross-bracing; three new bents

of piles were driven and capped, several bents were recapped, additional stringers were put in, the fences and sidewalk bulkheads were repaired, and other small repairs made, at a cost of $2,909.94. Some additional work on top of the bridge was done by the Bridge Division of the Street Department.

CHARLES-RIVER WATERSHED IN WEST ROXBURY.

In compliance with the following order of the City Council, dated May 8, 1893, "that the City Engineer be and he hereby is requested to make surveys and plans, and furnish estimates, for draining the Charles-river watershed in West Roxbury," the following report was made:

The district comprises that part of West Roxbury which drains naturally into Charles river, and in devising a plan for the drainage of this territory it is also necessary to include with it Hyde Park, Dedham, and Milton. The city has already built an extension of the main drainage system through a part of Dorchester, which will probably be complete as far as Lower Mills early next year, and it is expected that it will at once be extended as far as Central avenue.

This branch of the main drainage system was designed to take the drainage from the district under consideration, and I recommend that it be continued through Hyde Park to Weld street, West Roxbury, as shown on the accompanying plan, and that a system of sewers be built in the streets substantially as shown on said plan.

At present only the street sewers, shown in red, about 11½ miles, need be built.

The estimated cost of the proposed system is as follows:

51,239 feet of sewer, from Central avenue to Weld street	$388,201
4,200 feet (Germantown branch)	8,810
	$397,011
Engineering and contingencies	39,701
	$436,712
Land damages	32,000
	$468,712
11½ miles street sewers	166,000
Total	$634,712

The surface drainage should be excluded from this system and taken care of by the existing watercourses.

The following is the report from Assistant Engineer Mr. F. A. McInnes:

BOSTON, December 10, 1894.

WILLIAM JACKSON, ESQ., *City Engineer:*

DEAR SIR: I herewith submit a report, with plans and approximate estimates, on the sewerage of that portion of West Roxbury now unprovided with sewers.

The need of proper sewerage facilities for that part of West Roxbury sloping towards the Charles river and Mother brook is beyond question, and needs no further comment. The best method of disposing of the sewage, however, admits of more discussion. Obviously, the most inexpensive method would be to discharge the crude sewage directly, either into the Charles or into Mother brook. Neither of these methods can be seriously considered. In the case of the Charles, the fact that several towns farther down-stream take their water-supply from the banks of the stream is prohibitive, while the people living along Mother brook and the Neponset would not tolerate a discharge into those streams. To connect with the Metropolitan sewerage system in Newton is out of the question by reason of the enormous cost. Filtration through land would involve pumping and might affect injuriously the Brookline water-supply. Two courses of action remain which are more worthy of consideration. The first is to bring the sewage to a common point and thence pump it over the divide into the West Roxbury trunk sewer near Highland avenue, whence it would flow by existing sewers to Moon island. The second is to construct an intercepting sewer down Mother brook and the Neponset to the Dorchester intercepting sewer at Central avenue, thus enabling the sewage to flow by gravity to Moon island.

The plan of pumping over the divide, while undoubtedly much cheaper in first cost, cannot be recommended as a permanent solution of the question. The existing sewers in Roslindale and Jamaica Plain, which would be utilized, were not designed to receive sewage from outside the Stony-brook drainage area, and the inevitable growth of population on the Charles-river slope of West Roxbury would soon necessitate their reconstruction or duplication at great cost. This plan also involves greater running expenses. Furthermore, it would be difficult and costly, though possible, to connect the Roslindale sewer with the high-level sewer, which is designed to be built to relieve the present improved sewerage system. For present needs a temporary pumping plant might be established near the railway, with a force main to carry the sewage to Mt. Vernon street, a distance of about 8,700 feet, with a lift of 74 feet. This, however, seems an unwise expenditure, for any temporary arrangement of this kind must soon be superseded by a permanent one. Every argument for better sewerage facilities for West Roxbury applies with equal, and in some cases greater, force to Dedham, Hyde Park, and Milton. The intercepting sewer down Mother brook, etc., is the natural outlet for these towns, and it seems reasonable to expect that concerted action might be had with them. Milton has already taken definite steps towards a system of common sewers, while the people of Dedham and Hyde Park are keenly alive to the imperative need of better sewerage facilities, and they realize that action must be taken at once in the matter. Of the present population to be served by the Mother-brook intercepting sewer, less than 25 per cent. are in the city of Boston, while in 1930 it is estimated that 46 per cent. will be in the present area of Boston.

Another argument in favor of the outlet *via* Mother brook, etc., is the

fact that connection can be easily made with the high-level sewer, as will be more fully explained later in this report.

The Dorchester intercepting sewer (now almost complete to Milton Lower Mills), in anticipation of the action here recommended, was designed large enough to take the part of the sewage of Dedham, Hyde Park, and Milton, which naturally drains into Mother brook and the Neponset.

In view of these facts, the outlet *via* Mother brook has been decided upon, and careful surveys have been made of the route to be followed.

In designing the sewers no allowance has been made for storm water, — it being assumed that the natural watercourses will be improved for that purpose. Whenever possible permanent under-drains, emptying into the natural watercourses, have been placed under the sewer, and consequently but a slight allowance has been made for ground water. The probable population in the year 1930 has been estimated and made the basis of maximum flow. The population in 1930 of the parts of Newton and Brookline served by the proposed sewer was estimated at 8,000. The population in 1930 on the Charles-river slope of West Roxbury was estimated at 24,500 (present population about 2,400); Dedham's population in 1930 was estimated at 18,000, of whom 15,300 would use the sewer; Hyde Park's at 35,000, of whom 28,000 would use the sewer; and Milton's at 18,000, of whom 5,000 would use the sewer. The sewage of 24,000 people in Dorchester would also enter at Mattapan.

In computing the maximum flow, 130 gallons in twenty-four hours was allowed for each person in Newton, Brookline, Dedham, West Roxbury, and Milton, and 162 gallons for each person in Hyde Park and Mattapan, — the higher rate was adopted for Hyde Park and Mattapan because of their more nearly urban character. Branch sewers, draining small areas and the upper part of the intercepting sewer, were designed with double the capacity called for above.

The maximum capacity required at different points is as follows:

MAXIMUM FLOW, 1930.

Below Gardner street	3.53	c.f.p.s.
" Spring street	3.89	"
" Washington street	6.75	"
" Mill Lane street	9.15	"
" Readville street	10.80	"
" Central Park avenue	13.05	"
" Metropolitan avenue	15.55	"
" Mattapan station	20.80	"
Above Central avenue	23.80	"

The original design of the Boston improved sewerage system contemplated the construction of a high-level sewer which should drain the portions of the city above grade 40 and flow by gravity to Moon island. The Neponset-valley branch of this sewer presents no engineering difficulties: it would tap the Mother-brook intercepting sewer at Central Park avenue and could take the whole flow at that point.

In view of the relief to be afforded by the high-level sewer, which it is assumed must of necessity be built before 1930, it is unnecessary to give the Mother-brook sewer the capacity required for the estimated flow at that date.

In estimating the flow to be taken by the high-level sewer, 101 gallons per head in twenty-four hours was used. This sewer will run under a head for a considerable distance, the whole pipe being filled irrespective of the flow. If designed for the maximum flow, the velocity at times would be insufficient to prevent deposits, and frequent

flushing would be necessary by emptying the sewer. The smaller flow of 101 gallons may be expected to prevail for a part of almost every day. Thus computed, the quantity which will be taken from the Mother-brook sewer at Central Park avenue by the high-level sewer is 9.26 c.f.p.s., leaving 3.79 c.f.p.s. to overflow into the low-level sewer at times of maximum flow. As it is improbable that the high-level sewer will be built until long after the flow at Central Park avenue reaches 3.79 c.f.p.s., it was decided to give the intercepting sewer a capacity of 8½ c.f.p.s. when flowing up to the normal flow line, the ultimate capacity being much more.

The following table shows the capacity below Central Park avenue, as designed:

	1. Est. total maximum flow in 1950, c.f.p.s.	2. Quantity which high-level sewer will take, c.f.p.s.	3. Leaving for low-level sewer, c.f.p.s.
Central Park avenue	13.05	9.26	3.79
Metropolitan avenue	15.55	10.31	5 24
Mattapan Station	20.80	10.31	10.49
Above Central avenue	23 80	10.31	12.49

	4. Normal capacity for which low-level sewer was designed, c.f.p.s.	5. Ultimate capacity of low-level sewer flowing full, c.f.p.s.
Central Park avenue	8.5	About 13.5
Metropolitan avenue	8.5	" 13.5
Mattapan Station	13.5	" 21.2
Above Central avenue	(13.5) (*17.0)	" (21.2) " (*26.2)

* Short section on steeper grade.

The normal flow line of the 2 ft. 6 in. × 2 ft. 7 in. sewer was considered to be 1 ft. 6 in. above the water-line, and of the 3 ft. × 3 ft. 1 in. sewer, 1 ft. 9 in. above the water-line.

NOTE. — It may be possible to take more of the Hyde Park sewage into the high-level sewer; the estimate is decidedly on the safe side.

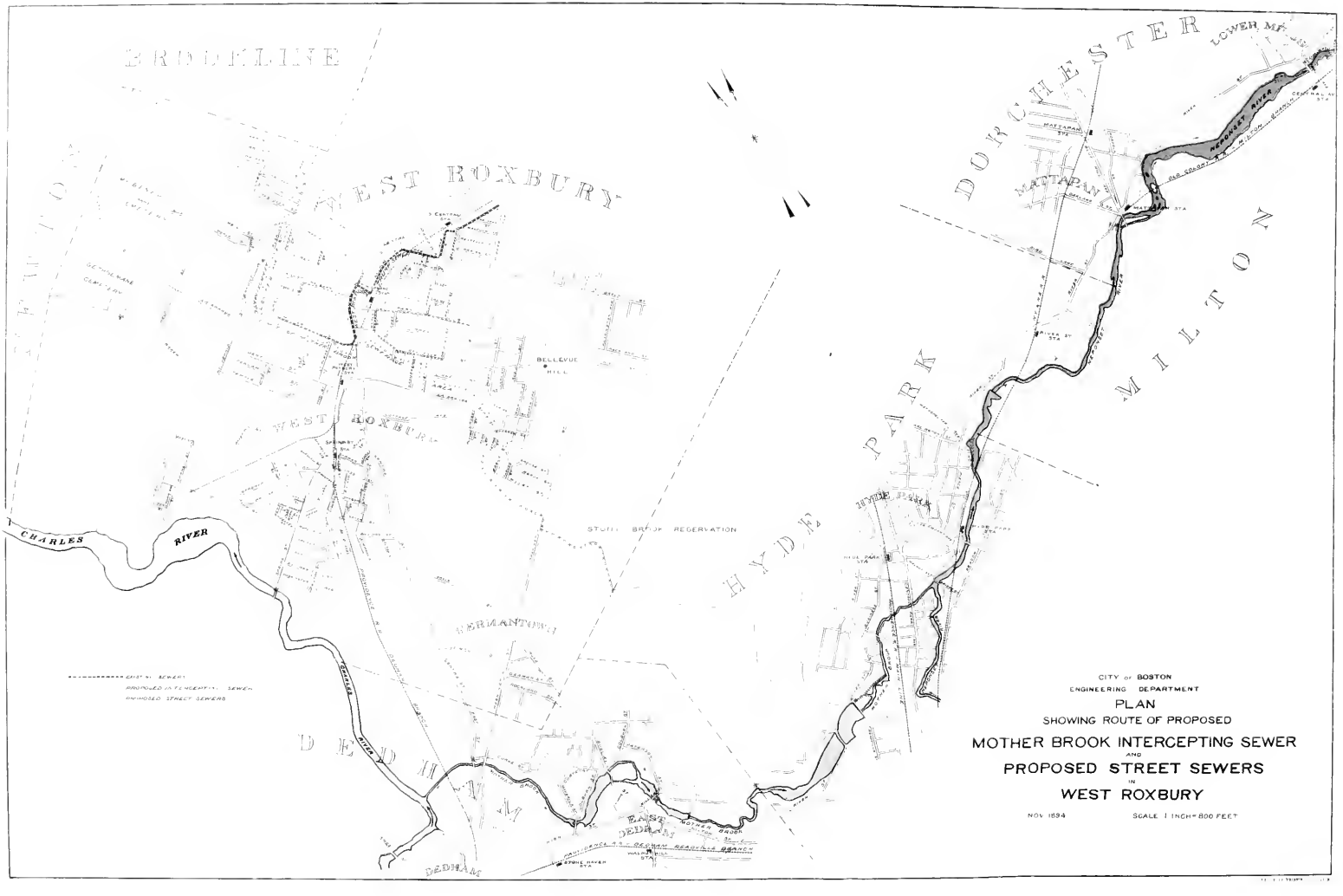
Provision is made in the design for an overflow into Mother brook below East Dedham, for use in emergency, such as an extraordinary flow, or when the sewer below needs repairs. Inexpensive flushing-gates have been provided at short intervals. The course of the sewer is shown on the accompanying plan. During the survey, different routes presented themselves, and in some cases a route other than the one chosen is worthy of consideration. This is notably the case between Hyde Park and East Dedham, where the south side of Mother-

brook may prove to be the best location. The grade and sizes of sewer are shown on the profile.

The intercepting sewer, as designed, is low enough to serve all parts of the territory considered which are likely to be inhabited, except certain low areas near Readville and beyond. To make the intercepting sewer deep enough to serve these areas would greatly increase the costs.

In the estimate of cost, the lack of precise knowledge of the rock profile is the chief element of uncertainty. No borings were made, but a careful examination of surface indications was relied upon. An underdrain was estimated throughout.

To extend the Dorchester intercepting sewer to Central avenue from its present terminus at Baker's court will cost $28,000. As this extension is now necessary, and must be soon constructed, its cost is not included in the following table showing estimated cost of the Motherbrook intercepting sewer from Central avenue to Weld street, in West Roxbury.


BRIDGELINE
WEST ROXBURY
DORCHESTER
LOWER MILLS
NEPONSET RIVER
MATTAPAN
MILTON
HYDE PARK
BELLEVUE HILL
STONY BROOK RESERVATION
CHARLES RIVER
CHARLES RIVER
DEDHAM
EAST DEDHAM
MOTHER BROOK
DEDHAM
EXIST'G SEWERS
PROPOSED INTERCEPTING SEWER
PROPOSED STREET SEWERS
CITY OF BOSTON
ENGINEERING DEPARTMENT
PLAN
SHOWING ROUTE OF PROPOSED
MOTHER BROOK INTERCEPTING SEWER
AND
PROPOSED STREET SEWERS
IN
WEST ROXBURY
NOV. 1894
SCALE 1 INCH = 800 FEET

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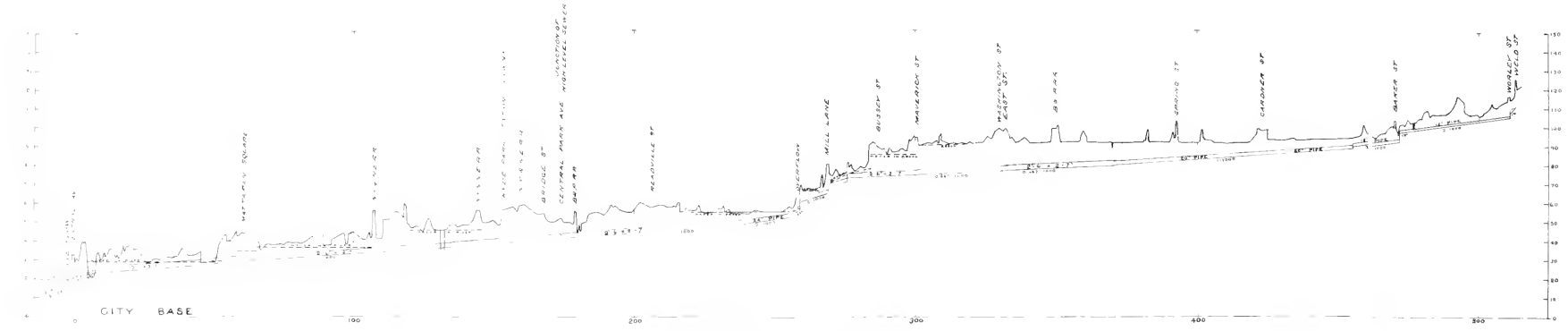


PROFILE OF PROPOSED MOTHER BROOK INTERCEPTING SEWER

CITY OF BOSTON – ENGINEERING DEPARTMENT

Estimate of Cost by Sections. — Mother-Brook Intercepting Sewer.

Section.	Station.	Length in Feet.	Size of Sewer.	Cost of Structure.	Av'age Cut.	Cu. ft. of Rock.	Cost of Excavat'n	Total Cost.	Av. per Foot.	Remarks.
12	— 1 + 50 to 32 + 0	800 2,450	2′6″ × 2′7″ 3′0″ × 3′1″	$15,167	9.4	65,000	$18,237	$33,404	$12 78	Cost of overflow included.
13	32 + 0 " 64 + 0	3,200	3′0″ × 3′1″	16,006	9.4	52,000	14,931	30,937	9 67	Easy digging; water; some piles required.
14	64 + 0 " 100 + 0	3,600	2′6″ × 2′7″	12,971	9.8	2,000	7,348	20,319	5 64	Easy digging; water; a few piles.
15	100 + 0 " 134 + 89	3,489	2′6″ × 2′7″	11,120	13.5	97,000	28,473	39,593	11 35	Water probably.
16	136 + 0 " 168 + 0	3,200	2′6″ × 2′7″	11,464	15.3	10,000	12,404	23,868	7 46	Easy digging.
17	168 + 0 " 206 + 50	3,850	2′6″ × 2′7″	11,313	12.2	10,000	10,994	22,307	5 79	Easy digging.
18	206 + 50 " 240 + 0	3,350	2′6″ × 2′7″	12,176	10.5	27,000	11,355	23,531	7 02	Water; some piles.
19	240 + 0 " 276 — 0	3,600	24″ pipe.	10,400	6.5	24,000	7,140	17,540	4 87	Some water.
20	276 + 0 " 332 + 0	5,600	2′6″ × 2′7″	17,278	16.1	230,000	66,645	83,923	14 99	Hard digging; lots of water; deep cut.
21	332 + 0 " 392 + 0	3,800 2,200	2′6″ × 2′7″ 24″ pipe.	27,353	15.2	2,000	23,000	50,353	8 39	Marsh mud; deep cut; many piles required.
22	392 + 0 " 469 + 50	3,250 3,050 1,450	24″ " 20″ " 18″ "	19,549	9.3	4,000	10,707	30,256	3 90	Easy digging; some piles.
23	469 + 50 " 513 + 0	700 3,350 300	18″ " 15″ " 12″ "	6,219	11.1	1,000	5,495	12,170	2 80	Easy digging.
	Total length . .	51,239					Total,	$388,201	$7 58	
Germantown Branch,	0 to 42 + 0	4,200	12″ pipe.	4,136	6.1	10,000	4,674	8,810	$2 10	
								$397,011		
	Engineering and office expenses (10%)							39,701		
								$436,712		

The amount of land damages is uncertain, but may be roughly estimated at $32,000, bringing the total cost up to $168,712.

The study for the street sewers in West Roxbury was made in less detail. The sewers included in the estimate are shown in red on the plan, and they will serve all parts of the district which are now so thickly settled as to require sewerage, and are so designed that they can, eventually, be extended to all parts of their respective drainage areas. The cost of an under-drain has been included for each sewer. In length the system aggregates 11.5 miles, and the estimated cost is $166,000.

In conclusion I wish to acknowledge the services of L. F. Cutter, of this office, who was intrusted by me with the task of working out the scheme here presented.

(Signed) F. A. MCINNES,
Assistant Engineer.

CHELSEA-STREET BRIDGE.

A contract was made August 20, 1894, with B. F. Nay & Co., for rebuilding the pile-bridge draw foundation and pier. The driving of the piles was begun September 17, and the bridge will be completed early next year, at a cost for contract work of $15,241.53.

A contract was made September 6, 1894, with the Boston Bridge Works for building the steel and iron draw. The work will be completed early next year at a cost of $8,460. The turning gear and rack was furnished by Miller & Shaw. The sheathing of bridge and draw was done by the Street Department.

The bridge is built on the location of the old bridge, and is 344 feet long and 30 feet wide between fences, having one 6-foot sidewalk. The grade of the curb at the draw is 19 feet above city base, being 3 feet higher at the draw than the old bridge. The grade descends from the draw at the rate of 3 feet per 100; this necessitated raising the grade of the Chelsea abutment, which was done by the city of Chelsea.

There are two draw-openings of 36 feet each.

The bridge is supported on bents of oak piles 16 feet apart, with hard-pine caps and stringers. The deck of the bridge is of 4-inch hard-pine with 2-inch spruce sheathing. The sidewalk is of 3-inch hard-pine planks.

The draw is of the centre-bearing type, and consists of two lines of plate-girders 4 feet 6 inches deep, and 113 feet 3½ inches long over all. The ends of the girders when in motion are supported by suspension rods passing over samson posts, and the whole weight of the superstructure is transmitted to centre by means of two cross-girders attached to a centre casting which is hung to the centre pivot by 6 wrought-iron suspension bolts 2½ inches in diameter. The centre pivot is 8½ inches in diameter, and turns upon two

hardened steel discs. The steadying drum is 24 feet in diameter, and consists of two curved pieces of 15-inch I-beam, each piece being in length about one-quarter of the circumference of the drum circle. The drum is supported by 30 cast-iron wheels 18 inches in diameter and 5-inch face, running on a cast-iron track secured to the wooden foundation.

The flooring of the draw has hard-pine stringers, 4-inch kyanized spruce lower plank and 2-inch spruce sheathing. Adjustable end bearings are provided for supporting the ends of the draw when closed.

The following is a copy of the license to rebuild, granted by the Secretary of War:

Whereas, By section 3 of an act of Congress, approved July 13, 1892, entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," it is declared that it shall not be lawful to construct by authority of the legislative act of a State any bridge, not already authorized by law, over a navigable water of the United States wholly within the limits of such State, without the approval of the Secretary of War of the location and plans of such bridge:

And whereas, The city of Boston, Commonwealth of Massachusetts, having authority under an act of the Legislature of the State of Massachusetts to construct a bridge over Chelsea creek, at Chelsea street, in Boston, in said State, has submitted plans of the same:

Now therefore, This is to certify that the location, and the plans of said bridge which are hereto attached, are hereby approved by the Secretary of War, subject to the following condition:

That the Engineer Officer of the United States Army, in charge of the district within which the bridge is to be built, may supervise its construction, in order that the said plans shall be complied with.

(Seal.)

Witness my hand this 7th day of May, 1894.

Signed) JOSEPH B. DOE,
Acting Secretary of War.

COTTAGE FARM BRIDGE, OVER THE BOSTON & ALBANY RAILROAD.

The abutments of this bridge have been extended to provide for a new bridge of a width equal to that of Commonwealth avenue at this point, and a retaining-wall built on the northerly line of Commonwealth avenue, between the northerly abutment and Essex street.

The plans and specifications for this work were prepared by the Engineering Department, and the work done by Leavitt, Daily, & Crockett, for the sum of $40,219.80.

Dorchester-avenue Grade Crossing.

Three different plans, with maps and estimates, have been prepared for abolishing the present dangerous crossing at grade of Dorchester avenue by the New York, New Haven, & Hartford Railroad.

The plan approved by the Board of Aldermen and now awaiting legislative action, involves a new location of the railroad for a considerable distance. Leaving the present railroad location at a point near the South Boston depot, the proposed line avoids the present crossing of Dorchester avenue by keeping to the west, and crossing Swett street about 600 feet west of the avenue; then turning to the left it crosses Boston street and Dorchester avenue, joining the old location of the railroad at Mt. Vernon street, Swett and Boston streets, and Dorchester avenue, and carried over the railroad.

Dover-street Bridge.

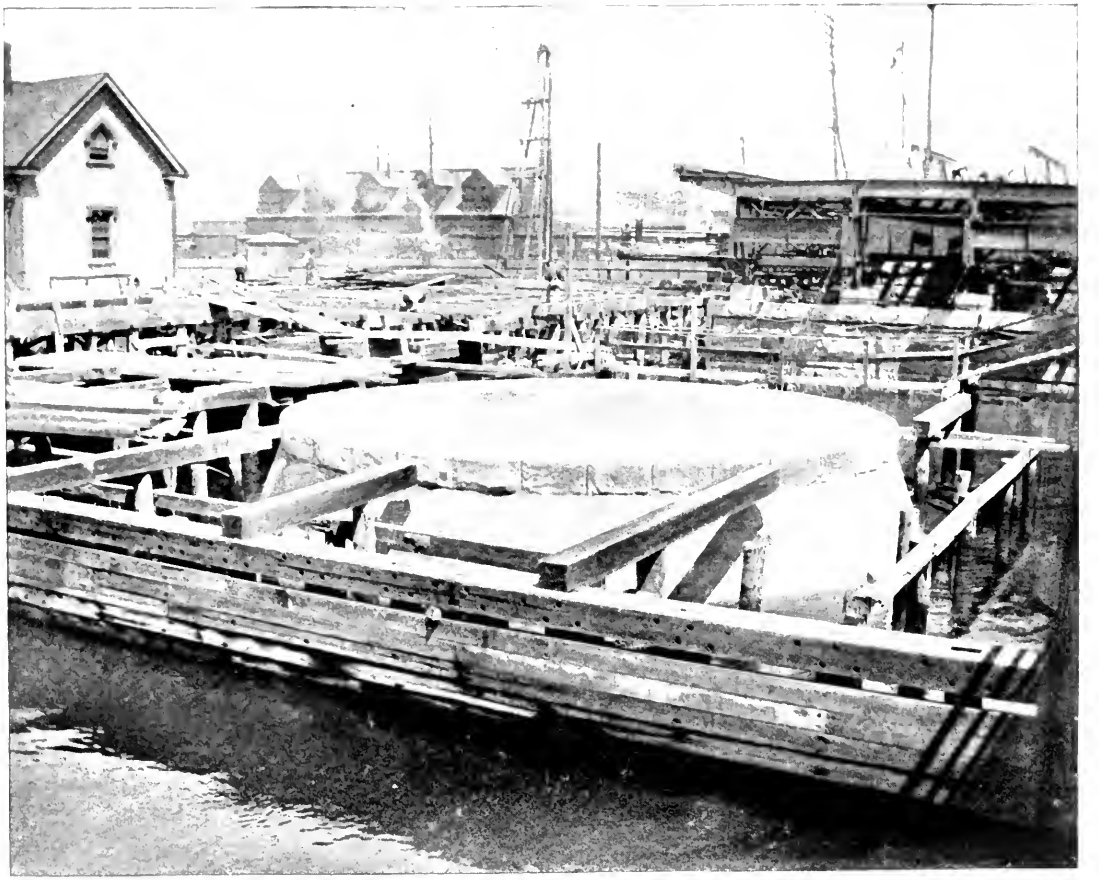
In accordance with the provisions of a decree of the special commission for the alteration of the grade crossing of the Old Colony Railroad and West Fourth street, the city of Boston was directed to rebuild Dover-street bridge.

The bridge as rebuilt consists of four fixed spans and one draw span, with masonry piers for the fixed spans, and a cement concrete pier for the draw span.

The masonry piers are four in number, and rest upon foundations of piles and cement concrete. The bottom of Fort Point channel, over which the bridge is built, is composed of a moderately soft clay overlaid by mud. From 2 feet to 6 feet of the mud was dredged from the area to be occupied by the piers, and spruce foundation piles driven in two sets. The first set, or low-grade piles, were cut off at grade — 9 feet for piers 1 and 2, and grade — 10 feet for piers 3 and 4. The second set or high-grade piles were cut off at grade — 2 feet for all piers.

After the piles were driven and cut off, a curbing of sheet piling was constructed around the space to be occupied by the concrete foundation, and filled with Portland cement concrete to grade 0. Below grade — 2 the concrete was deposited in the water through iron chutes; above this point it was deposited while the curbing was free from water, and was carefully rammed and levelled to form a good bed for the lower course of masonry. The concrete was made of one part Portland cement, two parts of sand, and five parts of broken stone or pebbles — all parts by measure.

Above grade 0 the piers are made of granite, laid in



DOVER-STREET BRIDGE, FOUNDATION PIER FOR DRAW

mortar made of one part Portland cement and two parts sand. The courses in the pier are 2 feet thick. The lower course of each pier is made of two lines of stretchers, with closure stone at each end of course. The beds of this course are dressed or split to lay not more than 1-inch joint, the builds dressed to lay ½-inch joint, and the vertical joints to lay ½-inch joint for one foot from the face of pier, and 1-inch to 2-inch joints for the balance of the joint.

The second course from the foundation is made of headers extending the entire thickness of the pier. The courses between the header course and coping are of ashlar masonry, laid in "Flemish bond," with special bond and stones at ends of pier. Stretchers are not less than 23 inches wide where the piers are 4 feet thick, and not less than 24 inches wide where thickness of pier exceeds 4 feet.

Vertical joints for 1 foot from face of pier, and the beds and builds of all stones are dressed to lay ½-inch joints. The backs of the stretchers are quarry split. Pier faces of the stones are quarry faced and pitched to line.

The spaces in the middle of the pier, between the stretcher courses, were filled with concrete of the same kind used in the foundation.

Coping courses are 2 feet thick and 5 feet wide, rough hammered on top.

After the completion of the pier the sheet curbing was cut off at about grade — 6 feet.

The foundation piles of the draw-pier are of spruce, and were driven and cut off in two sets in a manner similar to these of the masonry piers; the low-grade piles being cut off at grade — 10 feet, and the upper-grade piles at grade + 3 feet.

The sheet curbing around the piles enclosed a space 47 feet square, with secondary lines of sheeting across the corners, to give an octagonal shape to the base of the pier.

The curbing was built with its upper wale timbers at grade + 6 feet, and was filled with Portland cement concrete to this grade.

The concrete below grade — 2 feet was deposited in the water through chutes, and above this grade it was deposited in layers, while the curbing and forms were free from water.

From grade + 6 feet to its top, the pier is in the form of a truncated cone, and is made of concrete, with the exception of a coping ring of granite 6 feet wide and 21 inches thick, and two pedestal stones in the middle of the pier.

The concrete used in the pier was of the same proportions as that used in the pier for fixed spans.

A ring of steel channel-beams, 34 feet in diameter, was

imbedded in the concrete 3 feet 6 inches from the top of the pier.

The fender-pier at the draw was partially rebuilt, and a pile fender-guard built on the down-stream side of the bridge, from the draw-channel to the Boston end of the bridge.

The bridge superstructure consists of four steel-plate girder deck-spans, and a steel-plate girder deck draw-span. The bridge is 60 feet wide over all, this width being divided into two sidewalks 10 feet wide and a roadway 40 feet wide.

Spans 1, 2, and 3, on the Boston side of the draw-channel, are 80 feet long between bearings, and span 4, on the South Boston side of the draw-channel, 61 feet 8 inches long; each plan has four main plate girders spaced 15 feet on centres, and 8 feet deep in spans 1, 2, and 3, and 7 feet 9 inches deep in span 4, the depth being measured from out to out of flange angles.

Floor-beams are built beams and rest on the upper flanges of the girders.

Roadway and sidewalk stringers are steel I-beams riveted to floor-beams.

Roadway plank of fixed spans is 6-inch hard-pine, planed on heart side to an even thickness, jointed and fastened to hard-pine nailing pieces on stringers with 10-inch steel-wire spikes. The plank is painted with a preservative preparation, put on hot, and covered with four thicknesses of roofing felt laid in roofing pitch. On this roofing felt a mixture of sand and road pitch, from $\frac{3}{4}$ inch to 1 inch thick, is laid.

The surface of the roadway is of granite blocks, from 6 inches to $6\frac{1}{2}$ inches deep, laid on a thin bed of sand, with joints filled with pebbles and road pitch.

The sidewalk plank of fixed spans is 3-inch kyanized spruce plank, and is covered by a walk with a pebble and road-pitch base, and a 1-inch thick asphalt surface.

The draw is a deck swing span, with rim-bearing turntable, and is 60 feet wide over all and 168 feet 6 inches long on centre line of roadway. The main girders of the draw-span are two in number, 9 feet deep over turntable, 4 feet deep at ends, and 163 feet 4 inches long over all. They are placed 36 feet apart on centres. Floor-beams, sidewalk brackets, and cross girders at turntable are plate girders. The turntable is rim-bearing and 34 feet in diameter. There are two plate girder drums, one on the draw and one on the foundation pier, each drum being 3 feet 6 inches deep, and fitted with a planed and coned cast-iron track. The pier drum rests on cast-iron shoes bolted to the pier. The

wheels are 36 in number, 27 inches diameter, and 7½ inches face.

The roadway and sidewalk stringers of the draw flooring are of hard-pine, the under course of roadway floor is 4-inch kyanized spruce, the upper course 2-inch spruce, and the sidewalk plank 2-inch white-pine.

The draw is moved by an electric motor, which is operated from a controller attached to one of the sidewalk railings. The draw can also be turned by a hand lever, connecting with the same gearing to which the electric motor is attached.

The entire structure was designed by this department, and the work done by the following-named parties:

Masonry piers	Boynton Bros.
Fender-guard	Alex. McInnes
Foundation and fender-pier	Perkins & White
Steel superstructure, railing, and wooden flooring	Boston Bridge Works
Roadway paving and asphalt sidewalks	J Grant & Co.
Draw machinery	Miller & Shaw
Electric motor and wiring	General Electric Co.

EAST BOSTON FERRIES.

Ferry-boat "East Boston."

A contract was made with D. D. Kelley & Son, August 22, 1894, for lowering the deck of the ferry-boat "East Boston," and the work was begun November 12, 1894. The ends of the boat were lowered 18 inches, and the centre of the boat was raised 4 inches. A new deck was put in of 4-inch hard-pine, calked and graved. The fender-guard was repaired, the ceiling wedged, and the upper part of the outside of the boat was calked. The work was all done while the boat was afloat, and it was completed January 31, 1895. The cost of the contract work was $5,884.27.

New Drop.

A contract was made August 3, 1894, with Josiah Shaw, of Somerville, to build a new ferry drop in accordance with a plan and specifications furnished by this department. The new drop is placed on the southerly side of the North Ferry, East Boston, to take the place of an old drop reported as being dangerous in the last annual report. The contract price was $5,868.

New Tank.

A new tank for supporting the new drop was built by J. M Brooks, of East Boston, under his accepted proposal, dated September 10, 1894. Plan and specifications were furnished by this department. The cost of the tank was $1,881.24.

JOHN BOYLE O'REILLY STATUE.

The work of preparing the foundation for this statue has been done under the direction of this department, and contracts made for furnishing the granite base, curbing, and seats.

MUNICIPAL DOCKS.

In compliance with a request from His Honor the Mayor an estimate has been made of the cost of constructing a system of municipal docks at East Boston.

Various plans have been proposed, all of which contemplate a considerable number of large docks adapted for the accommodation of modern steamships.

The data available is incomplete, and therefore for the purposes of the estimate it has been assumed that no ledge would be encountered and that the docks could be so located that no extraordinary difficulties would be met with in constructing foundations for sea-walls. Upon these assumptions the estimated cost (exclusive of paved roadways, tracks, and buildings) of constructing sea-walls and filling the docks and the land necessary for approaches and storage, and for teams and railroads, would be about $7,500,000 per 10,000,000 square feet, estimating filling at 40 cents per cubic yard and sea-walls at $70 per linear foot.

The following is an estimate for utilizing a portion of the Bird Island flats, which belong to the city, as a beginning of the proposed municipal dock system.

The plan contemplates the closing of the present channel between East Boston and the flats and the taking of several of the existing wharves. The estimated cost (exclusive of roadways, buildings, etc.) for constructing two piers, to be 1,000 feet in length by 250 feet in width, with a filled area 300 feet in depth at the head of the docks for roadway, storage of cars, etc., with no allowance for land damages, is $850,000.

The assessed value of the land and docks which it would be necessary to take is $138,000.

CITY OF BOSTON
ENGINEERING DEPARTMENT

SKETCH SHOWING PROPOSED LOCATION OF DOCKS ON BIRD ISLAND FLATS

SCALE 200 FT. = 1 IN.
NOV 1894

PRESTON-STREET CULVERT.

In October, 1894, by request of the Superintendent of Streets, plans and estimates were made for a stone culvert with brick arch at Preston street, Dorchester. The construction of this culvert was afterwards supervised. It was built at a cost of $700.

STONY-BROOK IMPROVEMENT.

The improvement of Stony brook, from the Hyde Park line to a point 400 feet below Mt. Hope street, was completed during the past year by Messrs. Blake & Page, in accordance with their contract. The work consisted in widening the old channel below Ashland street to a bottom width of 10 feet, with side slopes of 1½ to 1, and in lowering the bed of the brook to a uniform grade of 0.6 foot in 1,000. The maximum cutting on the centre line below Ashland street being 2.4 feet; the culvert at Mt. Hope street was underpinned, and the Ashland-street culvert rebuilt. From Ashland street to the Hyde Park line a strip of land 30 feet wide was taken by the Board of Aldermen, and the old channel of the brook straightened and improved in conformity with the part below, a grade of 0.6 per 1,000 being maintained throughout; the maximum cutting on the centre line was 5.0 feet; the work extended over a total distance of 2,800 feet. Above the Hyde Park line the brook has been improved to some extent, and the bottom lowered to meet the new conditions below.

TEREDO NAVALIS.

In the report for 1893, a short account was given of the appearance of the Teredo Navalis in the waters of Boston Harbor. The succeeding winter apparently destroyed the entire colony, as no survivors were found, and none were reported in any part of the harbor.

The actual damage done to the property of the Eastern Dredging Company was about one thousand dollars.

TUNNEL, FRANKLIN STREET, BRIGHTON.
(ALLSTON SUBWAY.)
Under Boston & Albany Railroad.

This subway takes the place of the foot-bridge formerly crossing the railroad tracks at the Allston station. The complete plan of the subway included inclined approaches

along Franklin street from Cambridge street on the southerly side of the railroad, and from Lincoln street on the northerly side of the railroad, and also a side approach by stone steps at the southerly end of the subway proper. It was found that the original appropriation was not sufficient to build the inclined approaches, and plans were prepared for their addition at some future time.

The subway under the tracks is about 120 feet long and is 9 feet wide and 7 feet 9 inches high. The side walls are of Roxbury stone laid in Portland-cement mortar, and rest upon American-cement concrete foundations. The side walls are lined with white enamelled brick with base and top courses of brown brick, an air-space being left between the side walls and brick lining. The floor is of granolithic paving laid on a heavy foundation of cement concrete. Drainage is provided by a system of catch-basins and pipes connecting with a pipe sewer about 500 feet long extending to the main sewer in Franklin street.

The entrance to the subway at its southerly end is from one side by a flight of stone steps, and at its northerly end a temporary flight of steps is provided in line with the proposed inclined approach. The roof of the subway supporting the railroad tracks is made of 12-inch steel I-beams weighing 40 lbs. per foot, filled between with concrete arches built upon $\frac{3}{8}$-inch thick curved steel plates. Lead strips $\frac{3}{32}$ inch thick were placed between the plates and beam flanges, and the joints thoroughly calked from below. It was believed that these, with the concrete filling, would make water-tight joints; but that part of the roof under the present railroad tracks soon became leaky, and small copper gutters connecting with the air-space behind brick lining were placed under all beams.

The subway is lighted by incandescent electric lights.

The work, with the exception of the granolithic walk, was done by Jones & Meehan, and the granolithic walk was laid by Simpson Brothers.

The subway was opened on November 1, 1894, and the amount expended for same was $12,396.56.

B.

[FROM THE CITY ENGINEER'S REPORT TO THE BOSTON WATER BOARD.]

SOURCES OF SUPPLY.

The rainfall during the year 1894 was much below the average, and in consequence the supply of water in the different storage reservoirs was reduced to a very small amount.

The rainfall and quantities collected on the several water-sheds were as follows:

	Sudbury.	Cochituate.	Mystic.
Rainfall in inches .	39.74	39.08	39.24
" collected in inches .	16.182	12.99	14.40
Daily average yield of water-shed in gallons . .	57,937,800	11,674,000	18,429,500

Reservoir No. 1.

Grades, H. W., 161.00; Tops of Flash-boards, 159.29 and 158.41; Crest of Dam, 157.54. Area, Water Surface, 143 acres; Greatest Depth, 14 ft.; Contents below 161.00, 376,900,000; Below 159.29, 288,400,000 gals.

The surface of this reservoir was about 2 feet below the crest of the dam on January 1, 1894, and no water was wasted until February 23. With the exception of four days in April, water was wasted over the dam from February 23 until May 7, when the flash-boards were placed upon the dam. On May 26 the reservoir was full, and waste began over the flash-boards, continuing until June 13.

The flash-boards were removed on November 8, and waste occurred from November 8 to December 3, from December 16 to 22, and on December 27 and 28.

This dam is in good condition.

Reservoir No. 2.

Grades, H. W., 168.00; Tops of Flash-boards, 167.12 and 166.49; Crest of Dam, 165.87. Area, Water Surface, 134 acres; Greatest Depth, 17 ft.; Contents below 168.00, 568,300,000; Below 167.12, 529,860,000 gals.

This reservoir was 7 feet below the level of the top of the flash-boards on January 1, 1894. On February 23 the water level reached the crest of the dam, and the reservoir remained

full until the middle of June, when it was drawn upon for the supply of the city, and on July 17 it was 7 feet below the flash-boards. During August and September water was run into the reservoir from Reservoirs 4 and 6, raising the water surface about 2 feet, and in November and December it was gradually filled so that on January 1, 1895, the water surface was about 1 foot below high water.

The dam is in good condition.

Reservoir No. 3.

Grades, H. W., 177.00; Crest of Dam (no Flash-boards), 175.24.
Area at 177.00, 253 acres; Contents below 177.00, 1,224,500,000 gallons.
Area at 175 24, 248 acres; Contents below 175.24, 1,081,500,000 gals.
Greatest Depth, 21 ft.

On February 1, 1894, this reservoir was 2.68 feet below high-water mark. On February 21 waste began over the dam, and continued during the greater portion of the time until June 6. On July 18 the surface had fallen to 168.42, or 6.82 feet below the crest of the dam. On November 8 the reservoir was again full, and has continued at or near that point to the present time.

The dam is in good condition.

Reservoir No. 4.

Grades, H. W., 215.21; Tops of Flash-boards, 215.21 + and 214.89;
Crest of Dam, 214.23.
Area, Water Surface, 167 acres; Greatest Depth, 49 ft.; Contents below 215.21,
1,416,400,000 gals.

On February 1, 1894, this reservoir was 29.45 feet below high-water mark. It was gradually filling during March, April, and May, and reached high-water mark on June 6.

On July 17 it was drawn upon for the supply of the city, and on September 11 the reservoir was practically empty, and the outlet gate was closed. Since November 1 it has been gradually filling.

The dam is in good condition.

Reservoir No. 5.

Work upon the construction of the dam was commenced on April 10 by the contractors, and has been prosecuted throughout the year. About two miles of new highway have been built to replace a road cut off by the dam. Surveys have been made and plans and specifications are now being prepared for removing the shallow flowage in the reservoir from the dam to Southboro'. It is proposed to leave the shallow flowage on the Marlboro' branch of the reservoir, which is at a higher level, until next year.

The following report of Desmond FitzGerald, resident engineer, gives further information in regard to the work on this reservoir, as well as other matters connected with additional supply:

SOUTH FRAMINGHAM, MASS., January 1, 1895.

WILLIAM JACKSON, ESQ., *City Engineer*:

DEAR SIR: The following brief report of engineering work for the year 1894 on Additional Supply is submitted. Basin No. 6 was sufficiently completed on January 1 to be put into service, and furnished the city with water during the summer. It was filled in the spring, and as the water rose the riprap was added on the up-stream slope. Later in the season the walk on top of the dam was added, and the slope on the down-stream side sodded and seeded. The dam and basin may be said to be entirely completed, although the filter-beds in connection with Gate-house No. 2 have only been fairly commenced.

The branches and gates for the distribution of the water have, however, been placed in position. On the last day of April the taking plans were filled for Basin No. 5.

They covered 228 separate parcels of land, and the descriptions required 151 sheets of legal cap. The final locations of all the roads have been determined. There are 1.66 miles of road to be raised, 5.8 miles to be rebuilt, and 8.43 miles to be discontinued. The work of cross-sectioning the entire basin is now under way.

On April 10 Moulton & O'Mahoney began work on Basin No. 5, and have made excellent progress. The stripping under the dam has been completed, the trenches excavated, and the core-wall laid on its foundations for about half the length of the dam. In the centre of the valley the rock was found to be of very poor quality, as was expected, and the excavations were carried out deeper than the plans called for. The three 48-inch pipes in the Gate-house have been laid and covered with rubble masonry, and the foundations for the overflow carried across the bed of the stream and completed to grade 190. The following table shows the materials handled:

Soil stripping	29,794	cubic yards.
Earth excavation	36,548	" "
Rock excavation	14,607	" "
Concrete masonry	3,348	" "
Rubble "	6,410	" "
Brick "	21	" "
Range work "	164	" "
Dimension "	84	" "
Plastering "	1,207	square "

Early in the spring plans and specifications were prepared for building about two miles of new highway below the dam to replace a road cut off by the dam. Berry Bros. secured the contract on June 7, and work began on June 18, and was completed on November 16. The following is a table of quantities:

NOVEMBER 24, 1894.

Fourth and final estimate of work done and material furnished on two roads in Framingham and Southboro, by Berry Bros., under their contract dated June 7, 1894 (199–1894–27):

27,245	cubic yards	Earth excavation,	Item "*a*," at	$0.19	$5,176	55
555.4	" "	Rock " . .	" "*b*," "	1.25	694	25
287	" "	Split stone Masonry,	" "*c*," "	7.25	2,080	75
459.4	" "	Dry rubble "	" "*d*," "	3.75	1,722	75
113.2	" "	Paving in mortar	" "*e*," "	3.50	396	20
35.75	" "	Concrete . .	" "*f*," "	4.25	151	94
652.85	rods .	Stone wall . .	" "*g*," "	3.75	2,448	19
Total					$12,670	63

Very truly yours,

(Signed) DESMOND FITZGERALD,
Resident Engineer.

Reservoir No. 6.

Grades, H. W., 295.00; Top of Flash-boards, 295.00; Crest of Dam, 294.00. Estimated Area, 185 acres; Estimated Contents, 1,530,300,000 gals.

This reservoir was so nearly completed that it was used for the storage of water during the spring of 1894.

There was not sufficient rainfall to completely fill the basin, but the surface rose to within 2.25 feet of the high-water mark. During September and October water was taken from this reservoir for the supply of the city, and its surface was lowered about 18 feet. The outlet gate was closed on November 30, and on December 31 the water had risen to 278.78. The riprap on the up-stream slope of the dam has been completed, the down-stream slope sodded and seeded, and a walk made on the top of the dam.

In the fall it was found that a dam on a stream near the head of the reservoir had been rebuilt by the owners of the land, thus flowing a large swamp. The dam and about forty acres of land above have been taken for the purpose of removing the dam and deepening the brook.

The dam is in good condition.

Whitehall Pond.

Elevation, H. W. 327.91; Bottom of Gates, 317.78. Area at 327.91, 601 acres; Contents between 327.91 and 317.78, 1,256,900,000 gals.

On January 1 the surface of the pond was 2.97 feet below high water. During the spring it rose, and on June 4 was 326.82 or 1.09 below high water. On September 19 it had fallen to 324.35, and on October 25 to 322.40.

During October, November, and December it remained near this height, rising during the latter month to 323.23 on December 31. About 10,000,000 gallons per day were drawn from the pond from August 17 to 21, and from September 13 to October 18. During the remainder of the year no water was drawn from the pond except to supply Wood Bros.' shoe factory. Plans and specifications for a new dam at the outlet of the pond are now being made.

Cedar Swamp. — Surveys have been made for the taking of land, and plans and specifications have been prepared for the draining of the swamp.

Farm Pond.

Grades, H.W. 149.25; Low Water, 146.00.
Area at 149.25, 159 acres; Contents between 149.25 and 146.00, 165,500,000 gals.

No water was taken from this pond for the supply of the city. The surface of the pond was about .50 below high-water on January 1, 1894. On February 21 it reached high-water mark, and remained at or near that point until June 14. The lowest point reached was 148.17 on September 16, and on December 31 it was 148.79, or .46 feet below high-water mark.

The Framingham Water Company has drawn 117,000,000 gallons from the pond during the year.

Lake Cochituate.

Grades, H.W. 134.36; Invert Aqueduct, 121.03; Top of Aqueduct, 127.36.
Area, Water Surface, at 134.36, 785 acres; Contents between 134.36 and 127.36: 1,515,180,000; between 134.36 and 125.03, 1,910,280,000 gals.
Approximate Contents between 134.36 and 121.03, 2,447,000,000 gals.; Between 134.36 and 117.03, 2,907,000,000 gals.

The dam is in good condition.

On January 1 the surface of the lake was 6.42 feet below high-water mark. On March 13 water was turned into the lake from the Sudbury river, and on April 1 it was 1.76 below high water. On May 1 the lake was practically full, and it remained near high-water mark until the middle of June, after which its surface gradually fell until December 10, when it reached the lowest point during the year, 126.10 above tide-marsh level, or 8.26 below high water. Since that date it has risen slightly, and is now, February 1, 7.46 below high-water mark. The beds for filtering the water of Pegan brook have been in use during the greater portion of the year, and 192,447,000 gallons of water have been pumped on to the beds. No difficulty has been experienced in the operation of the beds during the winter.

Water has been drawn from the different reservoirs as follows:

From	7	A.M.	Jan.	1	to	1	P.M.	Mar. 15	from Reservoir No. 1.
"	1	P.M.	Mar.	15	"	11	A.M.	April 10	" " " 1, 2, 3.
"	11	A.M.	April	10	"	11	A.M.	May 19	" " " 2, 3.
"	11	A.M.	May	19	"	11	A.M.	May 21	" " " 2.
"	11	A.M.	May	21	"	2	P.M.	May 23	" " " 2, 3.
"	2	P.M.	May	23	"	11.30	A.M.	May 26	" " " 3.
"	11.30	A.M	May	26	"	7	A.M.	June 1	" " " 2, 3.
"	7	A.M.	June	1	"	2	P.M.	June 4	" " " 3.
"	2	P.M.	June	4	"	11	A.M.	June 11	" " " 2, 3.

From	11	A.M. June 11 to	11	A.M. June 20	from	Reservoir	No. 2.
"	11	A.M. June 20 "	7	A M. July 18	"	"	" 2, 3.
"	7	A.M. July 18 "	3	A.M. Aug. 24	"	"	" 2.
"	3	A.M. Aug. 24 "	7	A.M. Aug. 25	"	"	" 2, 3.
"	7	A.M. Aug. 25 "	3	P.M. Sept. 7	"	"	" 2.
"	3	P.M. Sept. 7 "	3	P.M. Sept. 10	"	"	" 2, 3.
"	3	P.M. Sept. 10 "	3	P.M. Oct. 30	"	"	" 2.
"	3	P.M. Oct. 30 "	3	P.M. Oct. 31	"	"	" 1, 2.
"	3	P.M. Oct. 31 "	1	P.M. Nov. 2	"	"	No flow.
"	1	P.M. Nov. 2 "	12	M. Nov. 17	"	"	" 2.
"	12	M. Nov. 17 "	7	A.M. Nov. 20	"	"	" 2, 3.
"	7	A.M. Nov. 20 "	3	P M. Nov. 21	"	"	" 3.
"	3	P.M. Nov. 21 "	1.20	P.M. Nov. 22	"	"	" 2.
"	1.20	P.M. Nov. 22 "	3	P.M. Nov. 23	"	"	No flow.
"	3	P.M. Nov. 23 "	3	P.M. Nov. 27	"	"	" 2, 3.
"	3	P.M. Nov. 27 "	3	P.M Dec. 1	"	"	" 2.
"	3	P.M. Dec. 1 "	11	A.M. Dec. 3	"	"	" 2, 3.
"	11	A M. Dec. 3 "	7	A.M. Jan. 1	"	"	" 1.

The heights of the water in the various storage reservoirs on the first day of each month are given below:

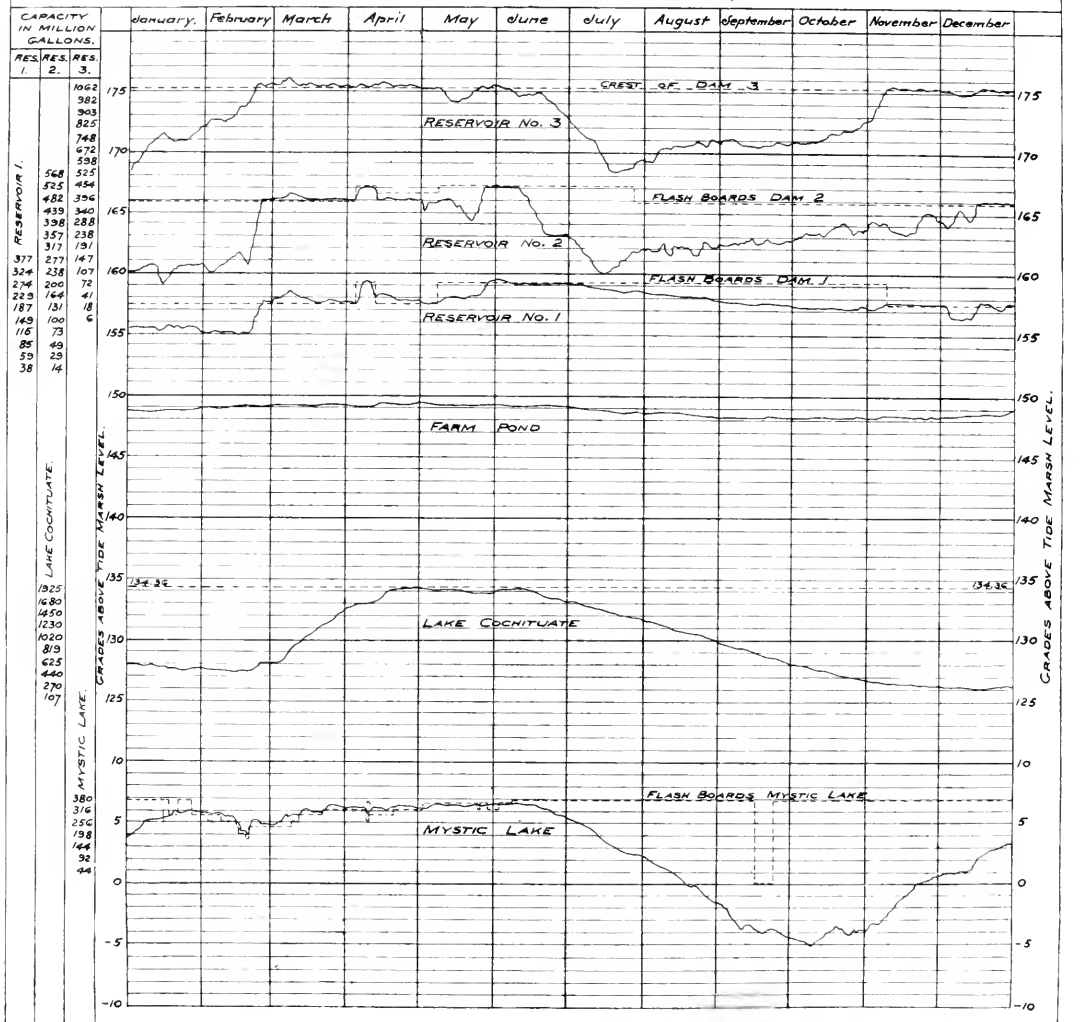
		Reservoirs.					Farm Pond.	Whitehall Pond.	Lake Cochituate.
		No. 1.	No. 2.	No. 3.	No. 4.	No. 6.			
		Top of Flash-boards.	Top of Flash-boards.	Crest of Dam.	Crest of Dam.	Top of Flash-boards.	High Water.	High Water.	Top of Flash-boards.
		159.29	167.12	175.24	215.21	295.00	149.25	327.91	134.36
January 1,	1894 . .	155.55	160.17	168.53	178.83	. . . .	148.74	. . . .	127.94
February 1,	" . .	155.05	160.61	172.32	185.92	259.33	148.98	. . . .	127.59
March 1,	" . .	157.87	166.12	175.54	192.70	268.42	149.27	. . . .	128.22
April 1,	" . .	157.71	166.01	175.40	204.84	281.52	149.32	. . . .	132.60
May 1,	" . .	157.75	166.02	175.39	211.39	288.26	149.50	326.700	134.13
June 1,	" . .	159.56	167.24	175.54	214.60	291.08	149.39	326.800	134.24
July 1,	" . .	159.12	162.92	172.62	215.26	292.66	149.03	326.435	133.24
August 1,	" . .	158.52	162.02	169.29	207.36	292.68	148.66	325.812	131.59
September 1,	" . .	157.86	162.57	170.92	191.63	292.54	148.34	324.900	129.88
October 1,	" . .	157.46	162.94	170.95	185.54	283.30	148.19	323.680	128.14
November 1,	" . .	157.34	164.08	172.77	187.55	274.23	148.34	322.570	126.74
December 1,	" . .	157.69	164.55	175.40	191.90	275.29	148.49	322.445	126.27
January 1,	1895 . .	156.50	166.00	175.24	196.18	278.84	148.79	323.230	126.28

AQUEDUCTS AND DISTRIBUTING RESERVOIRS.

The Sudbury-river aqueduct has been in use 343.7 days, and has delivered 11,450,600,000 gallons into Chestnut Hill Reservoir and 962,200,000 gallons into Lake Cochituate.

BOSTON WATER WORKS.

Diagram showing the heights of Sudbury River Reservoirs Nos. 1, 2 and 3. Farm Pond and Cochituate and Mystic Lakes during the year 1894.



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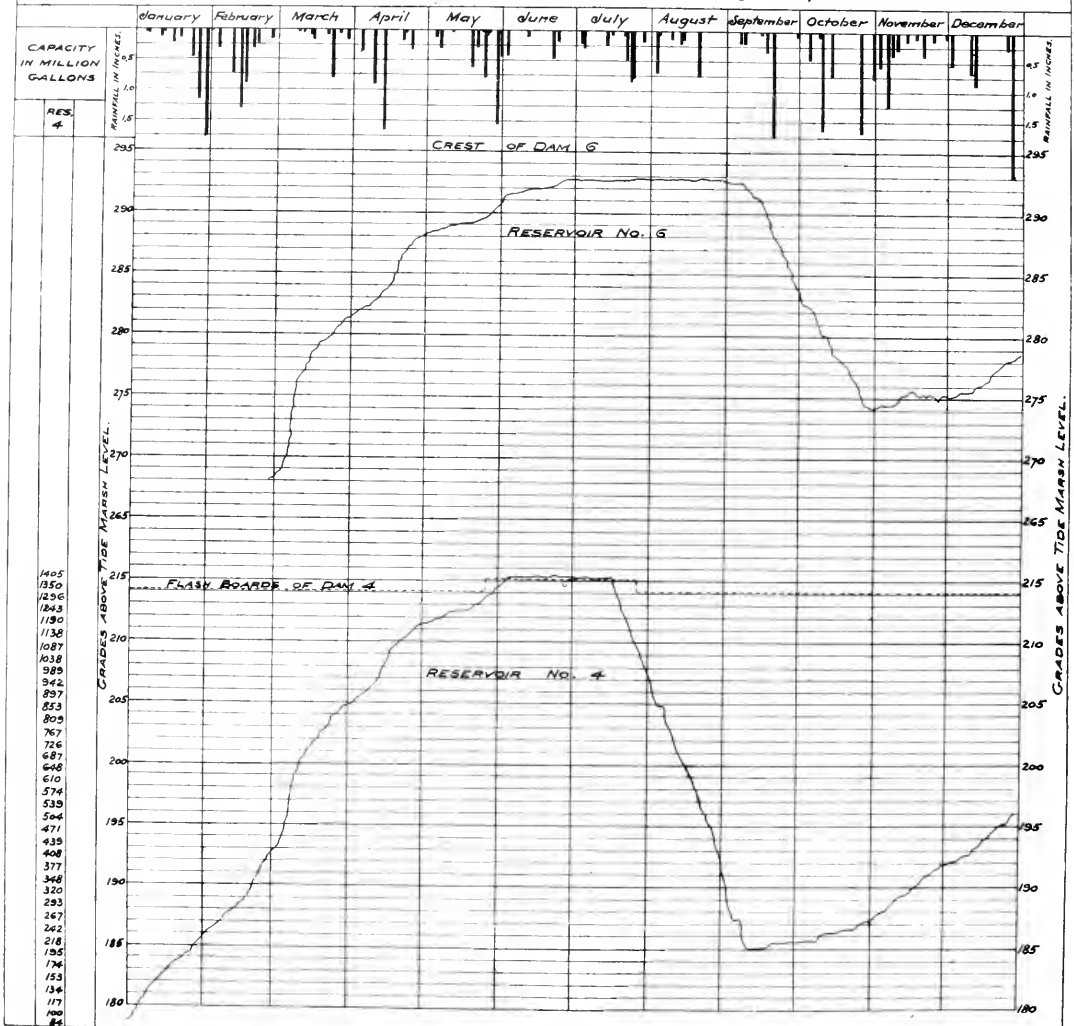
BOSTON WATER WORKS.

Diagram showing the heights of Sudbury River Reservoirs Nos. 4 and 6. and the Rainfall on the Sudbury River Water Shed during the year 1894.



The Cochituate Aqueduct has been used 361.5 days, and delivered 5,520,092,100 gallons. Both aqueducts have been cleaned during the year.

The distributing reservoirs are in good condition.

HIGH-SERVICE PUMPING-STATIONS.

The daily average quantity pumped at the Chestnut Hill station was 8.12 per cent. more than in 1893.

Engine No. 1 was run 4,401 hours 55 minutes, pumping	1,864,913,005 gallons
Engine No. 2 was run 4,642 hours 20 minutes, pumping	1,927,061,540 "
Engine No. 3 pumped	3,856,050 "
Total amount pumped	3,795,830,595 "
Total amount coal used	4,637,660 lbs.
Percentage ashes and clinkers	7.4
Average lift in feet	126.18
Quantity pumped per lb. of coal	818.59 gallons
Daily average amount pumped	10,399,500 "

Table VII. on page 78 shows in detail the work done by the engines and boilers.

COST OF PUMPING.

Salaries	$15,150 31
Fuel	7,929 59
Repairs	548 48
Oil, waste, and packing	842 59
Small supplies	660 81
Total	$25,131 78

Cost per million gallons raised one foot high	$0.052
" " " " pumped to reservoir	6.62

ENGINE NO. 3.

Engine No. 3 has been in process of erection during the year, and was started for the first time on December 3.

The work of lagging and painting the engine is now being done, and the work will soon be completed. This engine, shown on accompanying plates, possesses several novel features.

It has been built by the Quintard Iron Works, of New

York, from designs furnished by E. D. Leavitt, of Cambridge, Mass.

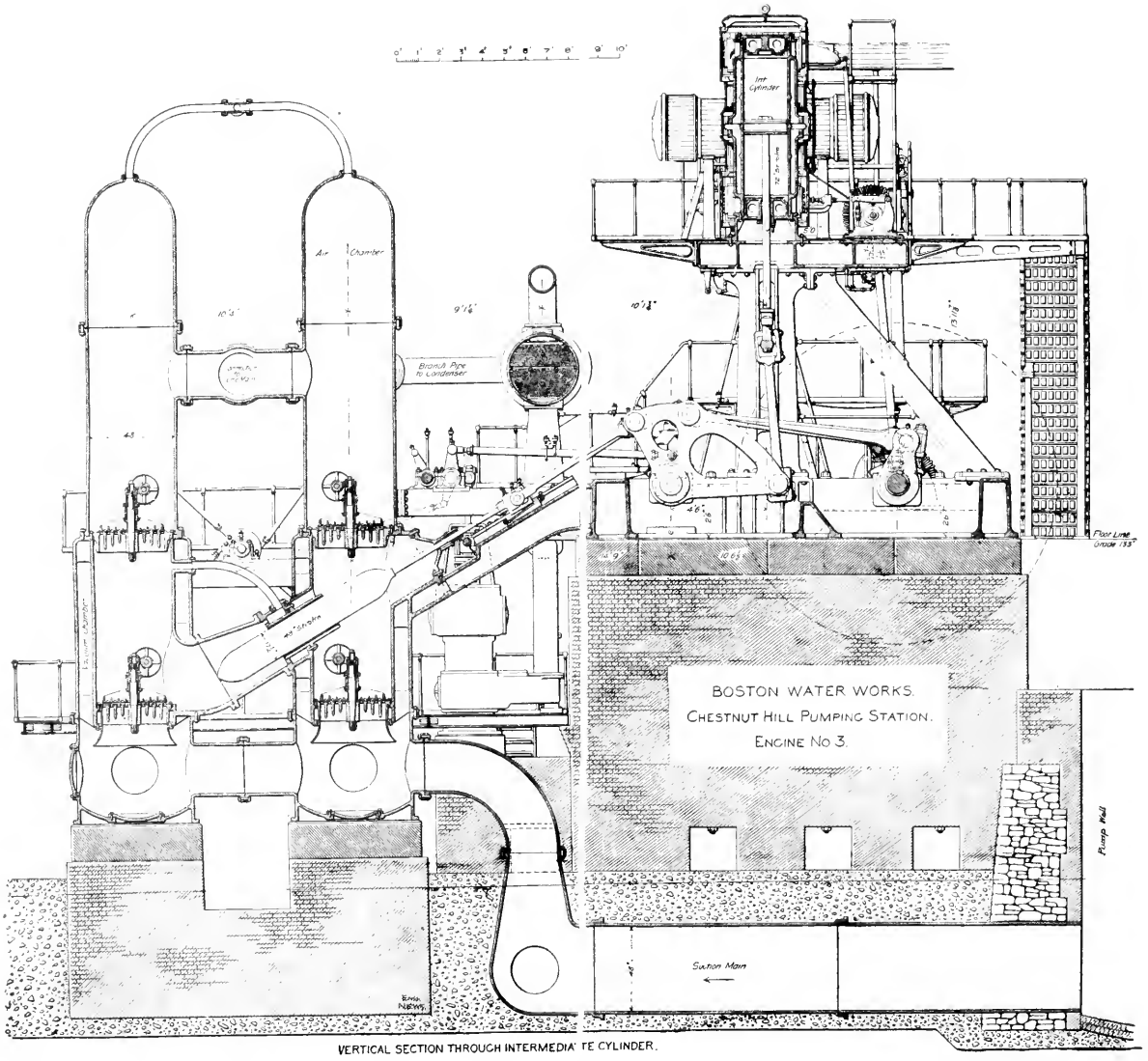
It is a triple expansion, three-crank rocker engine, with pistons 13.7, 24.375, and 39 inches in diameter and 6-foot stroke. The cylinders are vertical and inverted, and are carried together, with valve gear, on an entablature supported by six vertical and six diagonal columns.

The steam and exhaust valves are gridiron slides, worked by cams on a horizontal shaft, which is driven by gearing from the crank shaft. The cut-off of the high-pressure cylinder is regulated by the governor through the agency of a hydraulic cylinder, which advances or retards the cut-off cam by means of a spiral sleeve; the cut-offs of the other engines are fixed. The steam passes into the high-pressure cylinder through a separator forming a part of the inlet side-pipe. After expanding in this cylinder it passes through a tubular reheater to the intermediate cylinder, and thence through another similar reheater to the low-pressure cylinder. The reheaters have steam of boiler pressure, or 185 pounds per square inch, on the inside of the tubes, and the working steam on the outside.

All the cylinders are steam-jacketed on the heads and barrels, the low-pressure cylinder with steam at 100 pounds and the others at 185 pounds. The jackets and reheaters using steam of boiler pressure are drained back to the boilers, while the low-pressure cylinder jacket and the working-steam side of the reheaters are drained by automatic traps discharging into the feed-water heater.

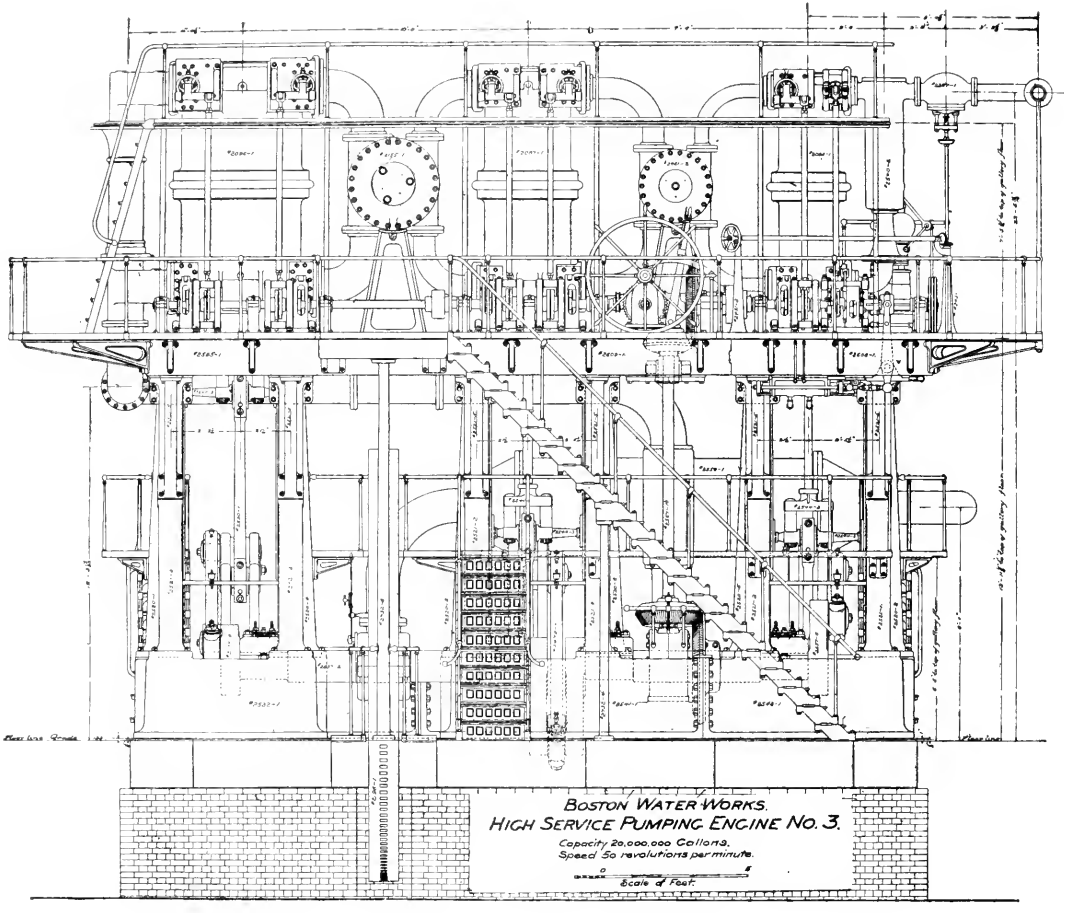
The engine cross-heads work on guides cast in the vertical columns. The motion is transmitted from the cross-heads by links to beams or rockers carried in pedestals on the bed-plate of the engine. From these beams the connecting-rods work off in one direction and the pump links in the opposite direction, but inclined at an angle of about 30 degrees from the horizontal. The leverage of the various pins in the beams is such that the stroke, which is six feet in the case of the steam pistons, is reduced to four feet for the pump plungers, which is also the amount of the double throw of the cranks. The crank-shaft has three cranks set at angles of 120 degrees, the low-pressure crank leading, followed by the intermediate and high-pressure cranks.

The shaft is carried in four adjustable four-box pedestals, with overhung end cranks. Between two of these pedestals is the fly-wheel, and between the other two the gear for driving the cam-shaft. There are three double-acting inclined pumps, having plungers 17.5 inches in diameter and of 4 feet stroke. The pumps are seated on foundations at a



VERTICAL SECTION THROUGH INTERMEDIATE CYLINDER.


TE CYLINDER


BOSTON WATER WORKS.
HIGH SERVICE PUMPING ENGINE NO. 3.
Capacity 20,000,000 Gallons.
Speed 56 revolutions per minute.
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Scale of Feet.

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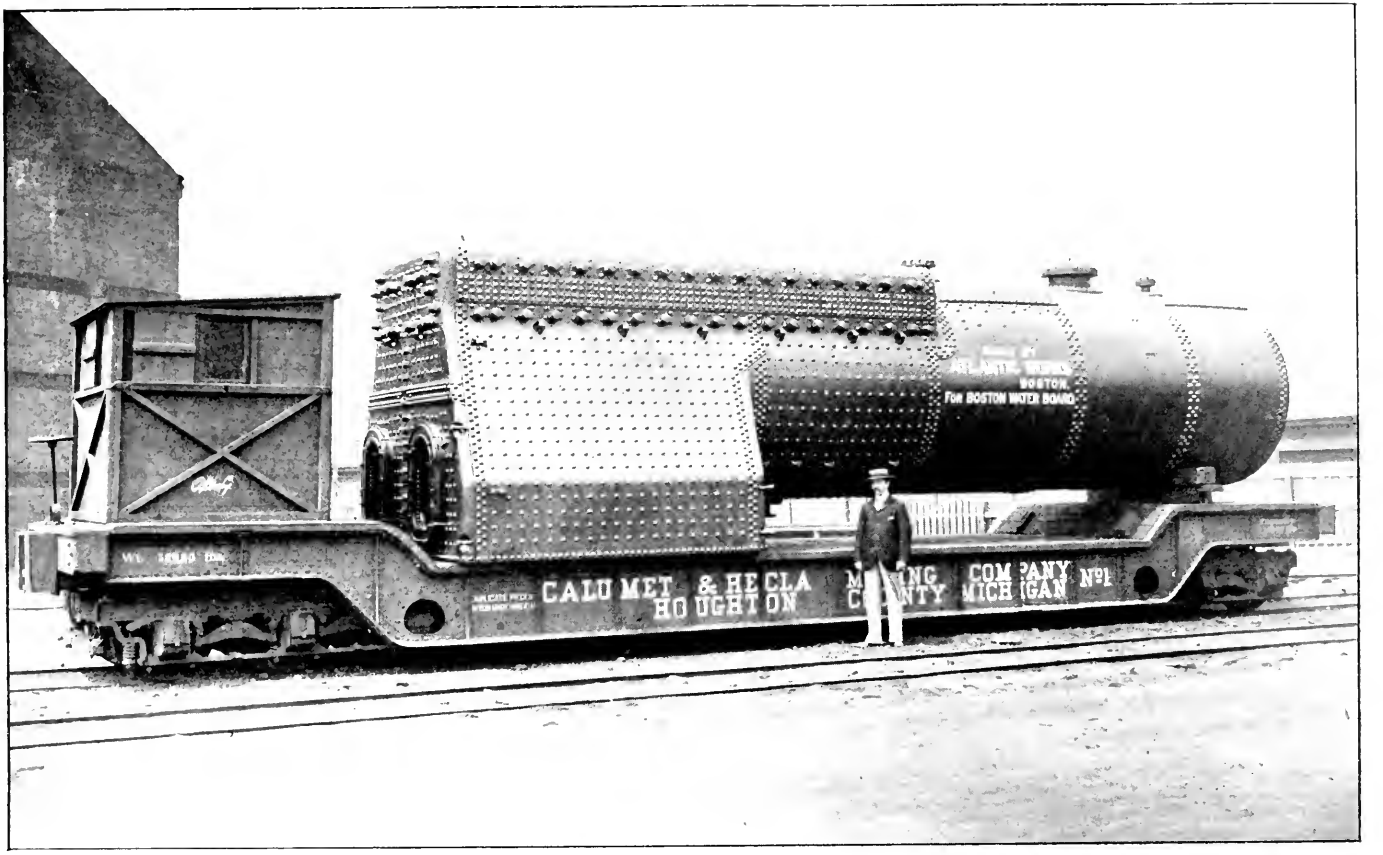

CALUMET & HECLA MINING COMPANY Nº1
HOUGHTON COUNTY MICHIGAN
For BOSTON WATER BOARD

FIG. 1

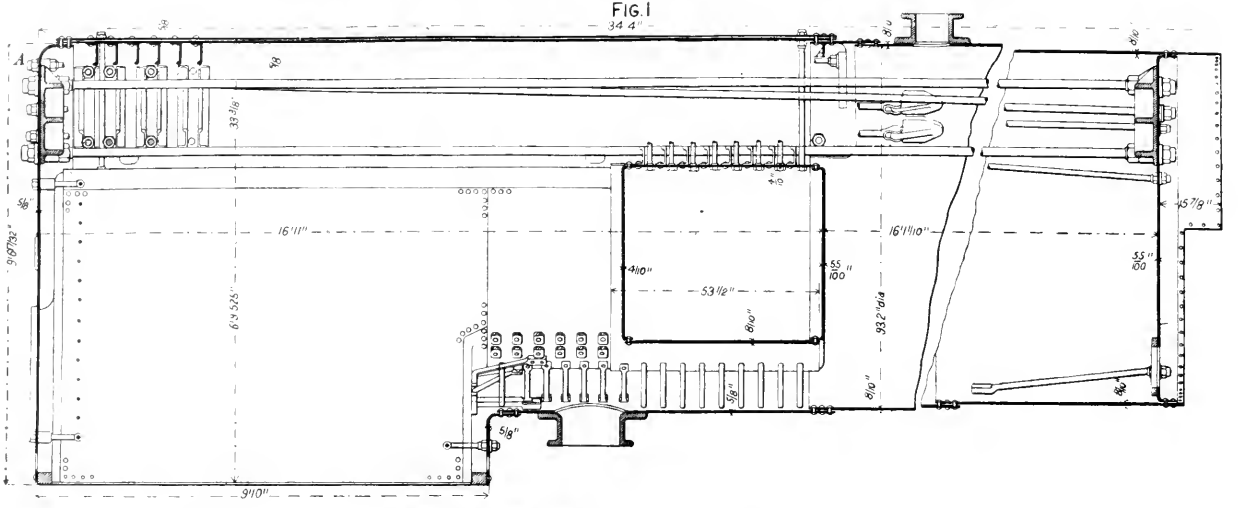


FIG. 2

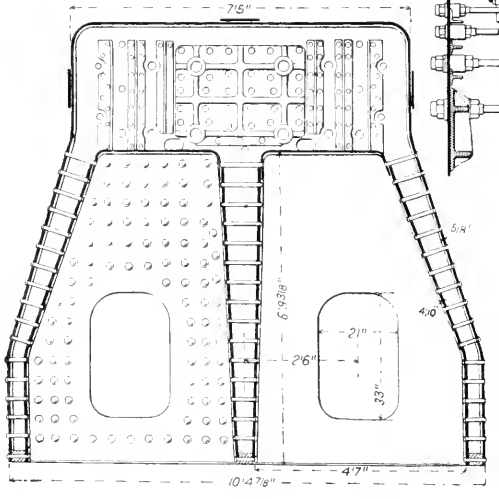


FIG. 5

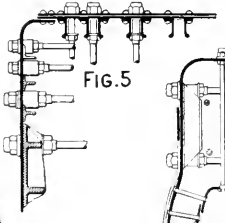


FIG. 3

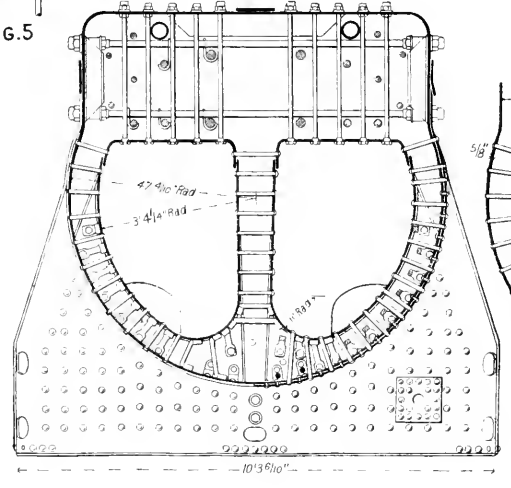
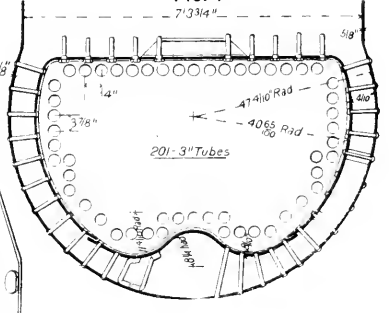
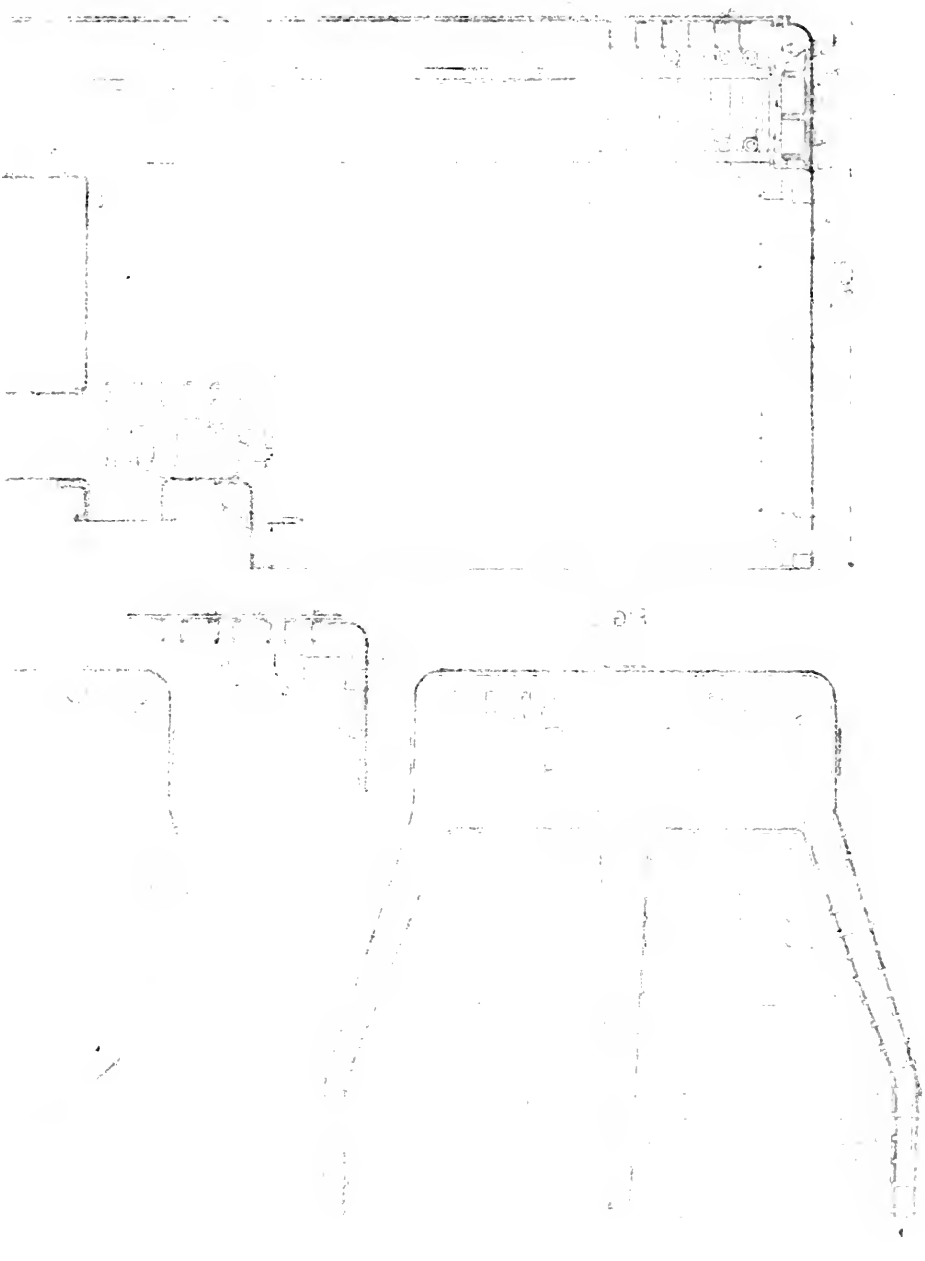


FIG. 4





lower level than those for the engines, the pump chambers being tied to the engine bed plate by horizontal girders, as well as by the pump cross-head guides, which are inclined 30 degrees from the horizontal. This peculiar arrangement of inclined pumps was found necessary to suit existing conditions of engine-house, pump-well, etc.

The pump bases, or suction chambers, six in number, one for each end of each pump, are connected together, and the bases of each pump are connected by a separate suction-pipe.

The lower or working pump chambers are surrounded by annular spaces throughout their height, forming vacuum chambers.

The upper pump chambers contain the delivery nozzles, and above these are the air chambers, all six of the latter being connected by pipes. Each end of each pump has one suction and one delivery valve, consisting of a number of rigidly connected rings covering annular openings in the valve seats. The speed necessary for the required duty capacity of 20,000,000 gallons per 24 hours is 50 revolutions per minute, but the engine has been designed to run easily at 60 revolutions. The head pumped against is 128 feet, or about 55 pounds per square inch.

Each pump contains one suction and one delivery valve, each about three feet in diameter. The use of these large valves, together with the phenomenally high speed, is made possible by the method of working the pump valves, which is the invention of Prof. Riedler, of the Royal Polytechnic School, of Berlin, Germany. This invention consists in closing each valve positively at just the moment of reversal of stroke by means of the levers and rods shown in the cuts.

After closing the valves the mechanism moves out of the way, leaving the valves free to open automatically. This is the first engine of the type built in this country, but they are no novelty abroad, being in use at many water-works, notably those of London, Berlin, Hamburg, Leipzig, Buda-Pesth, Breslau, Rotterdam, Heilbron, Manheim, Mulhausen, etc., at some of which places speeds of 75 revolutions per minute are attained.

The condenser is of the surface type, having 1,410 square feet of tube surface, with water passing through the tubes.

The condensing water is taken from one of the upper pump chambers, and after passing through the condenser is delivered into the force main. A butterfly valve in one of the pump discharge-pipes permits the quantity of condensing water to be easily regulated. The air-pump is of the single-acting bucket type, 24 inches diameter and 12-inch stroke,

situated directly below the condenser, and worked by an arm on one of the pump valve gear rocker shafts.

Steam for the engine is furnished by a Belpaire fire-box boiler having two separate furnaces and a common combustion chamber. The boiler is 34 feet 4 inches in length, with a least internal diameter of shell of 90 inches. The tubes are 201 in number, 3 inches in diameter, 16 feet long. The feed water, before entering the boiler, passes through a Green Economizer, where it is heated by the escaping gases from the boiler.

To accommodate the new boiler an addition has been made at the rear of the boiler-house at a cost of $3,597.25.

At the West Roxbury pumping-station the daily average quantity pumped was 121,500 gallons, an increase of 25.4 per cent. over the amount pumped in the previous year.

At the East Boston station 385,000 gallons per day have been pumped for the supply of the high-service district, and 30,800 gallons per day for the Breed's Island high service.

MYSTIC LAKE.

Grades, H. W., 7.00; Invert of aqueduct, —4.17; Contents between 7.00 and 1.50, 442,000,000 gallons.

On January 1, 1894, the lake surface was 3.15 feet below high water. On January 19 it had risen to grade 5.70 above tide-marsh level, and the stop-planks were removed from the dam. Waste continued from January 19 to 22, and from January 26 to May 3.

Additional stop-planks were then placed on the dam, and during the month of May the lake remained near high-water mark.

Waste occurred over the dam from May 21 to June 8, after which date no waste was permitted except at the conduit wasteway and at the fishway, which was finally closed on June 20. During July the lake surface fell from 5.46 to 2.35, and on August 31 the water was 8.42 feet below high water and but 2.75 feet above the conduit invert.

The temporary pumps used to raise the water into the conduit were then started, and the surface of the lake continued to fall until, on October 10, it was 12.08 feet below high water and 1.90 feet lower than any previous record.

On November 1 the water surface had risen to grade —3.72, and on November 15 the use of the temporary pumps at the lake was discontinued. On December 1 the lake surface was at grade 0.67, and on January 1, 1895, at grade 3.35. As the old engines and pumps which were in use at the lake were of insufficient capacity and badly worn, two new 60 H.P. engines and boilers and an 18-inch centrifugal

pump have been purchased. A pile foundation and wooden frame engine-house, 65 ft. × 19½ ft., has been built, and the new pump and one of the engines placed in position and connected with the conduit.

The dam at the outlet of the lake is in good condition.

MYSTIC–VALLEY SEWER.

During the year 1894, 116,908,000 gallons of sewage was pumped and chemically treated with sulphate of aluminum.

Table XI., on page 82, gives the monthly quantities of sewage pumped, coal and aluminum used, etc. With the completion of the North Metropolitan Sewer, which will occur during the present year, the operation of the plant will be discontinued.

MYSTIC CONDUIT AND RESERVOIR.

The conduit has been twice cleaned during the year.

In the annual reports for the past three years necessary repairs have been recommended at the conduit screen chamber, and as they have not yet been carried out the recommendations are renewed.

MYSTIC PUMPING–STATION.

Engine No. 1 was used 3,337⅚ hours, pumping	731,942,300 gals.
Engine No. 2 was used 2,585 hours, pumping	531,822,000 "
Engine No. 3 was used 7,518¼ hours, pumping	2,487,654,400 "
Total quantity pumped	3,751,418,700 "
Daily average quantity pumped	10,277,900 "
Total quantity of coal burned	8,763,800 lbs.
Percentage ashes and clinkers	11.2
Average lift in feet	148.62
Quantity pumped per lb. of coal	428.1 gals.
Average duty of engines per 100 lbs. coal, no deductions	53,057,500 ft.-lbs.

COST OF PUMPING.

Salaries	$11,242 27
Fuel	19,175 62
Repairs	1,576 30
Oil, waste, and packing	784 36
Small supplies	146 10
Total	$32,924 65

Cost per million gallons raised one foot high,	$0.059
" " " " pumped to reservoir,	8.777

Table VIII., on page 79, shows in detail the work done by the engines during the year. Work upon the new engine for this station has been in progress at the works of the G. F. Blake Manufacturing Company during the year, and the engine is now nearly ready for erection. On October 30, a contract was made with Mack & Moore for building an addition to the engine-house and for the necessary foundations for the engine.

Work under the contract was begun about November 1. The engine foundation is now nearly completed, and it is expected that the erection of the engine will be commenced by April 15 and completed during the year.

CONSUMPTION.

The daily average consumption for the year was as follows:

Sudbury and Cochituate Works . .	46,560,000 gals.
Mystic Works	10,282,100 "
Total for combined supplies . .	56,842,100 "

a decrease of 1,353,600 gallons, or 2.3 per cent. from that of the previous year. One cause of the decreased consumption was the warmer winter of 1893–94. The mean temperature for the month of January, 1893, was 10 degrees lower than for January, 1894. The consumption of the months of January, February, and March, 1894, was 473,372,500 gallons less than for the corresponding months of the previous year, equivalent to 1,296,900 gallons per day for the entire year. The decrease is also due in a considerable measure to the depression in business, as the quantity of water sold by meter measurement averaged 400,000 gallons per day less than in 1893.

On account of the insufficiency of the Mystic supply, all of the Charlestown District lying east of Cambridge street was supplied from the Cochituate works from 3.30 P.M., of September 12, until the end of the year. The following table shows the consumption per inhabitant for the past two years:

Consumption.

MONTH.	Cochituate.		Mystic.		Combined Supplies.	
	Consumption in Gallons per Capita.		Consumption in Gallons per Capita.		Consumption in Gallons per Capita.	
	1893.	1894.	1893.	1894.	1893.	1894.
January	123.7	108.1	111.5	91.9	120.9	104.5
February	117.6	109.6	103.7	95.4	114.5	106.5
March	111.4	99.7	91.9	83.0	107.0	96.0
April	104.1	88.9	76.9	79.0	98.1	86.7
May	99.0	92.6	76.7	82.1	94.0	90.2
June	100.4	101.4	81.5	96.4	96.1	100.3
July	110.6	110.3	80.6	93.3	104.0	106.5
August	108.3	104.0	77.6	81.8	101.5	99.0
September	105.5	98.2	71.8	94.3	98.0	97.6
October	104.2	95.0	75.7	80.1	97.8	92.6
November	99.3	94.8	75.0	81.3	93.9	92.7
December	106.9	97.5	90.9	92.8	103.3	96.7
Average	107.5	99.8	84.4	87.6	102.4	97.4

DISTRIBUTION.

On the Cochituate works, 17.88 miles of pipe were laid and 5.13 miles abandoned, making a net increase of 12.75 miles, and a total of 572.8 miles now connected with the system.

About three miles of the pipe which was abandoned was formerly connected with the Jamaica pond supply, and was located in streets where there were mains connected with the Cochituate system. The work of laying a new 36-inch force main from the Chestnut Hill pumping-station to Fisher Hill reservoir has been completed during the year.

The portion of the new 20-inch main for the supply of Brighton, which is in the town of Brookline, 3,446 feet in length, was laid by the superintendent of the Brookline works.

The relaying of the 20-inch low service and the 12-inch high service mains on Dover street, between Albany street and Dorchester avenue, caused by the change of grade and rebuilding of Dover-street bridge, has been practically completed.

The raising of the grade and abolition of grade crossings on Chelsea street, between Medford street and the

city of Chelsea, made necessary a relocation of the mains supplying Chelsea and East Boston. For a length of about 1,400 feet a 30-inch main has been substituted for the 24-inch and 20-inch mains supplying East Boston, and a 24-inch main substituted for the 16-inch main supplying Chelsea. These new mains have been laid outside the street location, on the property of the Boston & Maine Railroad Company.

The distributing mains connected with the Mystic works have been extended 6.89 miles, and 10.33 miles have been relaid, in most cases with pipes of larger diameter. The total length now in service is 173.7 miles.

There has been an increase of 175 in the number of hydrants connected with the Cochituate works, making a total now in use 6,217.

On the Mystic works 148 hydrants have been added, and the total now connected with the works is 1,435.

Two hundred and fifty-five petitions for main pipe have been reported upon, and 30 contracts for rock excavation have been made. Various profiles have been made, levels taken, and grades and lines furnished for the main pipe laying. All pipe laid has been located and plotted on the plans.

Corrosion of Pipes by Electrolysis.

The investigations of the effect of electrolysis upon the water-pipes have been continued during the year, under the supervision of Messrs. Stone & Webster, and in brief the results arrived at are as follows:

1. In certain places throughout the city electrolytic action is taking place, and pipes have already been more or less injured and are subject to premature decay.

2. The many excavations which have been made about the city for the purpose of inspecting the pipes have given only negative results, revealing no marked action, and yet not proving that the natural decay had not been accelerated by electrolysis.

3. Action of a serious nature is confined to special localities, where, owing to certain conditions of the railway system, abnormal currents are flowing through the earth, but as a whole, the action has been reduced to so small an amount that it is now difficult to detect.

4. In the places where action is found special precautions in provision of return feeders, and connections with the piping system by the Street Railway Company, will ordinarily reduce the difficulty to a small amount.

5. It is impracticable to entirely eliminate electrolytic

action, but by a constant inspection of the water system as a whole, with a view of locating points where difficulty is liable to occur, and applying such remedies as are well known, the danger can be reduced to a minimum.

6. The action at any one point is liable to increase or decrease temporarily from various causes, and tests made at any one locality at any specified time give no reasonable assurance that the same condition of affairs will exist for any considerable length of time.

7. A very small difference in potential, as little as one-thousandth of a volt, will cause electrolytic action.

8. Measurements of small difference of potential between water-pipes and the adjacent earth are of value principally in indicating the direction of flow of electric current rather than amount, and are not entirely reliable unless special precautions in measurements are taken.

This is on account of the battery action, thermal effects, and other disturbing influences.

9. The most practical way of reducing the liability of injury to pipes to a minimum is by detecting the places where action is occurring, through a carefully organized system of inspection and tests, and requiring the Railway Company to provide suitable return conductors or make proper connections with pipes or rails where it is found that such action exists.

10. Special provision can be made for measuring the flow of current from certain pipes to the ground, and, by devices of this sort installed at various places throughout the city, the most reliable information can be obtained in regard to the quantity of current flowing away from the pipes in any particular section, and a determination made of their actual rate of deterioration.

The following is Messrs. Stone & Webster's report in detail:

WILLIAM JACKSON, *City Engineer, Boston, Mass.:*

SIR: In accordance with your request, we have, during the past year, continued the investigation which was commenced some two years ago to determine the extent of the corrosive action of electric currents upon the pipes of the water system in the city of Boston, and beg to submit the following:

It has been our purpose during the past year to conduct such tests and experiments as would enable us to determine as definitely as possible the extent of the injury which has been done up to the present time, and also to predict, if possible, how long a time would probably elapse before damage of a serious nature would result to the piping system as a whole from electrolytic corrosion, if allowed to continue at its present rate.

It was clearly set forth in our report of a year ago that currents of a considerable magnitude were found to be flowing from place to place, through the earth and along the water pipes, but no definite conclusions

had at that time been reached as to the extent of damage already done and the rate at which it was progressing.

The results which have been obtained during the past year enable us to state quite positively that up to the present time the effect upon the piping system as a whole has not been serious in the city of Boston, although in other places where we have conducted tests during the past year, we have found that rapid decay was occurring, clearly due to electrolytic action. The reason of the slight action which has been found here is, primarily, that the street railway system is comparatively well equipped with return wires which conduct the greater part of the current back to the power-station without serious damage to the piping system.

Measurements of Potential of Piping System.

During the last year a large number of readings have been taken of the difference of potential between the hydrants and the adjacent ground, and it has been found that this difference, which was formerly in many cases quite large, has been reduced to a comparatively small amount in nearly all parts of the city.

The marked change in this respect over the tests made during the previous year shows that the flow of current from the pipes must have been materially reduced, and that the Railway Company are continually improving their system by bonding the rails and providing new return wires to the power station.

Some difficulty has been experienced in the investigation of this subject on account of the fact that changes in the return system of the Street Railway Company are made so frequently that difference of potential between pipes and surrounding earth in any particular locality frequently varies widely from time to time, and thus prevents any systematic study of the action which is taking place at a point where a considerable difference of potential is once discovered.

During the tests of a year ago, the greater part of our measurements, which were made for the purpose of determining the potential differences, were taken between the pipes, or the hydrants connected with the pipes, and the rails; but a careful study of the conditions convinced us that tests of this sort are unreliable, and consequently all measurements made during the past year have been taken between the pipes and the earth in their immediate vicinity.

The practical way in which the measurements have been made is illustrated in Plate I., where it will be seen that a rod is inserted in the hydrant box, and a metallic connection upon the bottom of this rod touches the ground in the vicinity of the pipe, while the other pole of the measuring instrument is placed in contact with the metal of the hydrant, the valve stem usually being used for this purpose.

In course of the investigation some question arose as to whether the true difference of potential between a pipe and the surrounding earth is obtained by a measurement of this sort, and in order to decide this question as definitely as possible, the following readings were taken at several points where excavations had been made throughout the city:

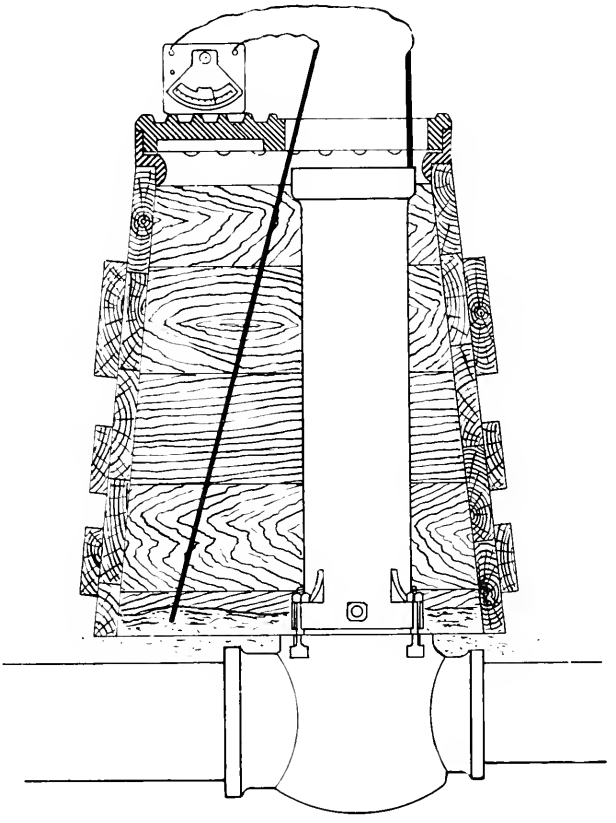
First. The actual difference of potential between the pipes and the ground immediately surrounding them, which is, of course, the measurement desired, was observed.

Second. The difference of potential between the pipe and the surface of the ground was observed.

Third. The difference of potential between the piping system and the earth at the base of the nearest hydrant box was measured in the way described.

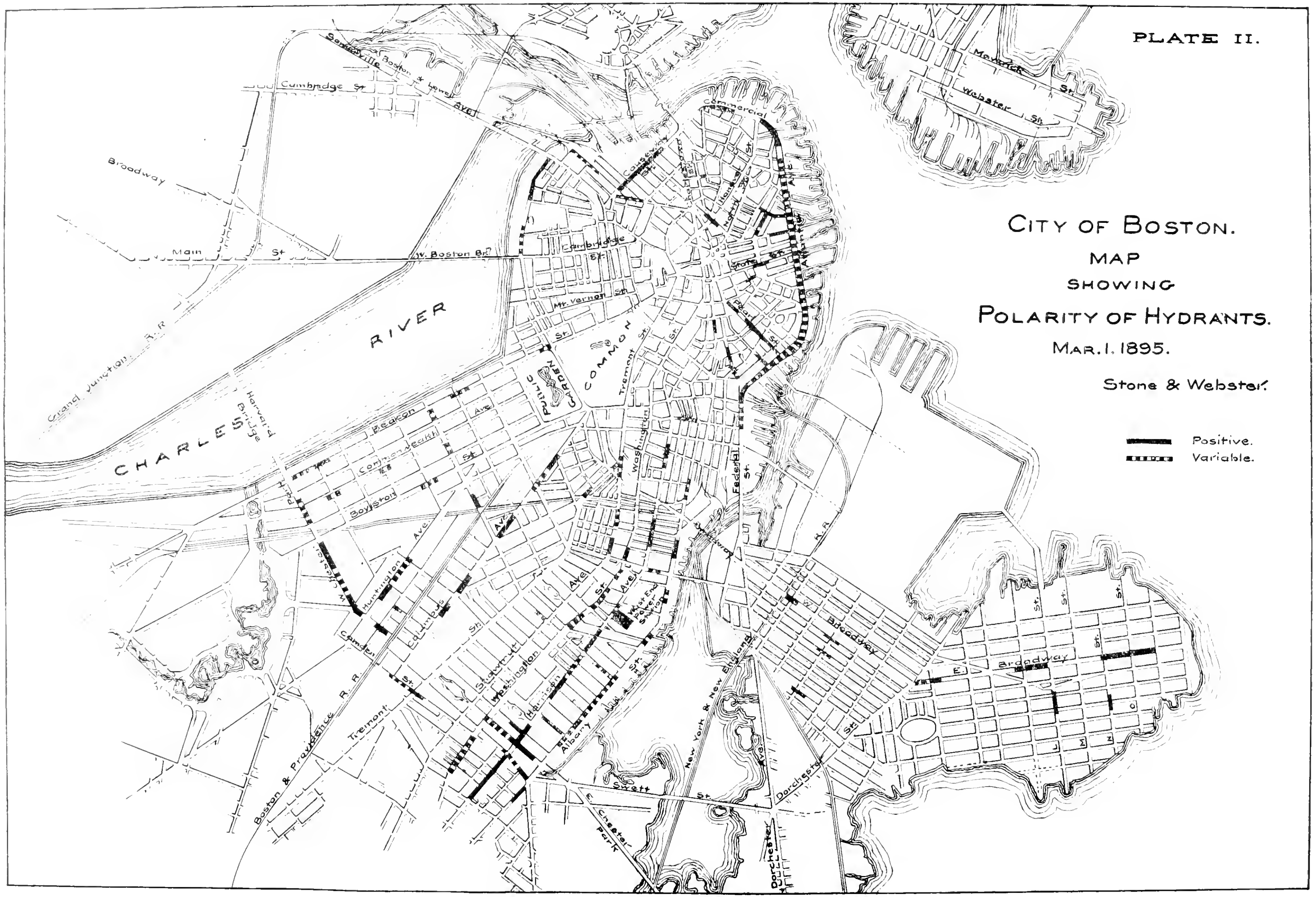
In the twelve places where satisfactory observations were made the potential between the pipes and the surface of the ground, and also the

PLATE I.



Stone & Webster.

PLATE II.



CITY OF BOSTON.
MAP
SHOWING
POLARITY OF HYDRANTS.
MAR. 1. 1895.
Stone & Webster.
Positive.
Variable.
CHARLES
RIVER
COMMON
PUBLIC GARDEN
Cambridge St
Broadway
Main St
W. Boston Br.
Grand Junction R.R.
Harvard Bridge
Beacon
Commonwealth
Boylston
Huntington Ave
Columbus
Tremont St
Washington
Harrison
Albany St
West End Power Station
Federal St
Atlantic Ave
Commercial
Causeway St
Maverick
Webster St
Swett St
Dorchester Ave
E. Chester Park
New York & New England R.R.
Boston & Providence R.R.
Camden St
Broadway
E. Broadway

potential between the pipes and the earth at the base of the hydrants, was found always to have the same sign as the potential between the pipes and the ground immediately surrounding them.

This would seem to prove conclusively that the method regularly adopted gives the correct polarity of the reading, and approximately the correct value.

The object of the various measurements which were made of the differences of potential was principally to determine the polarity, and the differences so obtained are to be considered of value as indicating the direction rather than the amount of current flowing.

Many measurements were taken in the city proper, and also in South Boston, East Boston, and Charlestown. The work was begun in January, 1894, and over 700 different hydrants have been visited and about 900 observations made. In many places the same hydrants have been frequently visited, to determine whether or not considerable changes in potential difference took place from time to time.

The results of these tests are on file, but we have not thought it necessary to insert them in this report, as the polarity at different points is indicated on the accompanying map, which shows the location of positive and negative hydrants throughout the city. The heavy full line shows a positive polarity, indicating a flow of current from the pipes to the ground, with consequent electrolytic action. The broken line shows a negative polarity at some observations and positive at others, and, being thus subject to change, it may be safely concluded that serious action is not going on in the district where such a state of affairs exist.

The results of these tests show that the theoretical assumption in regard to the existence of a clearly defined danger district is not borne out in practice, and that in a city where reasonable provision for the return of current to the power-station has been made, the effect of electrolytic action, though slight, is widely distributed.

In the immediate proximity of the power station most of the pipes were found very decidedly negative to the surrounding earth.

Pipes at points far remote from the power-station in a few places were found very decidedly positive, due in some cases to the fact that the railway return circuit is not sufficiently large, or is otherwise defective; and in others, to the fact that the piping system is not uniformly continuous in the direction of the power-station, and the return current has a tendency to follow it as far as possible, and then leave it for the earth.

From the observations made it has been shown that the potential and the polarity of the piping system in many places is continually changing, even when the quantity of current returned remains substantially the same.

This is due:

First. To the degree of moisture in the soil from time to time, which affects the electrical resistance of the earth as a whole.

Second. To the influences of electrically poor joints in the piping system.

Third. To the fact that lines of piping are not continuous from all parts of the city in a direct line to the power-station, on which account there is a tendency for the current to go across from one pipe to another, and the amount of current which so flows depends to a considerable extent upon the condition of the soil, which is subject to change.

Fourth. To the fact that the copper wires which bond the rails sometimes become corroded at the joints and affect the resistance of the return circuit, particularly where no supplementary wire is used.

Fifth. To the changes in the return system made by the Street Railway, from time to time, which, even if at points remote from the location of hydrants tested, make considerable differences in the potential observed.

Difference of Potential required to Produce Electrolysis.

The difference of potential obtained in the observations just described varies from 0.5 to .0005 volts, the average being perhaps about .02 volts.

It was formerly supposed that a difference of from 1 to 2 volts was required to produce electrolytic decomposition, but recent scientific investigations have been made which prove conclusively that a very small difference of potential is sufficient to cause electrolytic action.

As this question of amount of difference required for the production of electrolytic effects was an important one, we thought it desirable to conduct a series of tests with a view of determining, as definitely as possible, the minimum potential requisite.

For this purpose three cells were made up with electrodes of bright sheet iron immersed in a dilute solution of common salt.

The plates of the first cell (A) were subjected to an electromotive force of .01 volts; of the second cell (B) to an electromotive force of .002 volts, while the third cell (C) was not connected at all to the source of electrical supply, and was only used to observe the rate at which the natural rusting of the iron would take place.

The method of procedure was to immerse all the electrodes at one time, and after ten minutes to test for iron in the solution by means of ferricyanide of potassium. Then to test again, from time to time, and to note which cells showed the strongest reaction.

Three independent tests were made, all giving the same results, which were as follows:

Table showing Reaction in Test for Iron in the Electrolyte.

Time after immersion.	Cell (A) .01 volt.	Cell (B) .002 volts.	Cell (C) 0 volts.
10 minutes.	Trace.	Trace.	None.
20 "	Distinct.	Slight.	Trace.
30 "	Strong.	Distinct.	Just visible.
60 "	Strong.	Strong.	Slight.

From the above investigation it is obvious that an electromotive force, even so low as .002 volts, is sufficient to cause injurious action from electrolysis.

Flow of Electric Currents through Piping System.

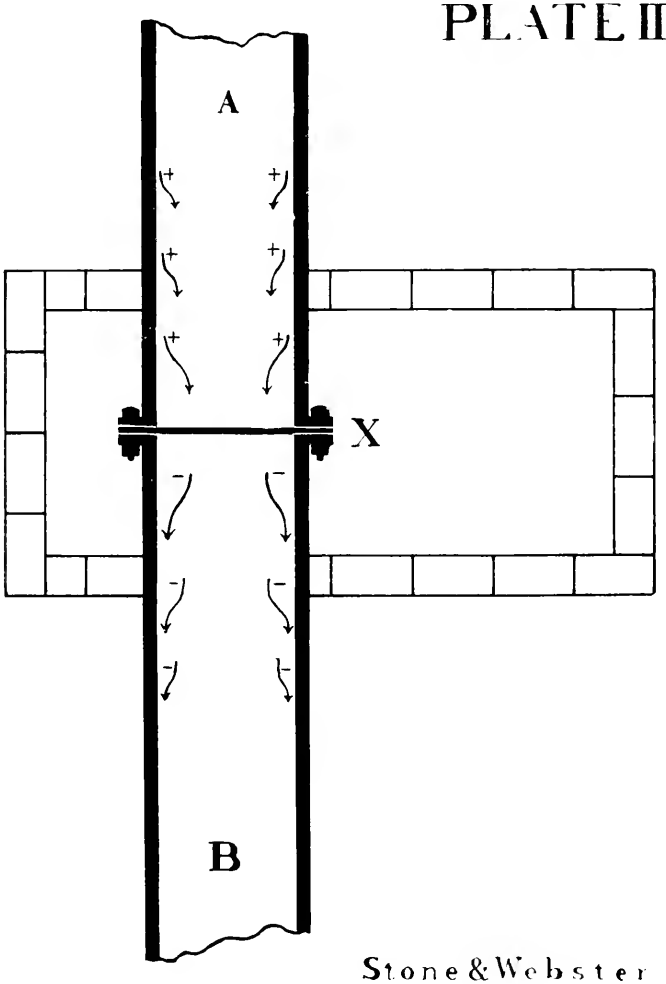
During the first year of our investigation into the matter of electrolytic action we secured abundant evidence that large currents were almost continually flowing through various parts of the piping system, and the question arose immediately as to the amount of damage that such currents were doing.

The tests made during the past year have confirmed the results obtained at first, and we have therefore thought this matter of sufficient importance to make it an object to conduct special laboratory tests to determine the probable extent and nature of injury resulting from this cause.

In this city no well-defined case of serious trouble from the passage of currents through the pipes themselves has been discovered, although some difficulty from electrical disturbances has been reported when making connections to the main water-pipe upon Dover street, near the South Boston bridge. But tests have so far revealed nothing of note. In other cities we have found serious action resulting from this cause at points where anything in the nature of an electrically insulated joint occurs.

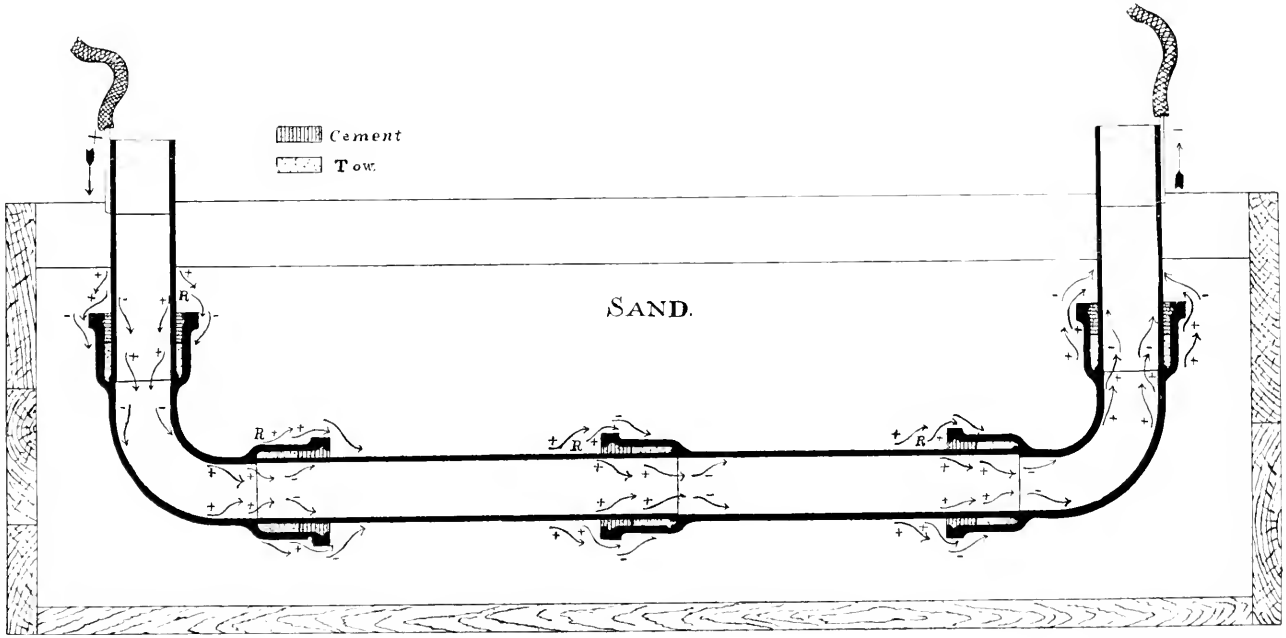
Plate III. shows a section of pipe which was examined under our

PLATE III.



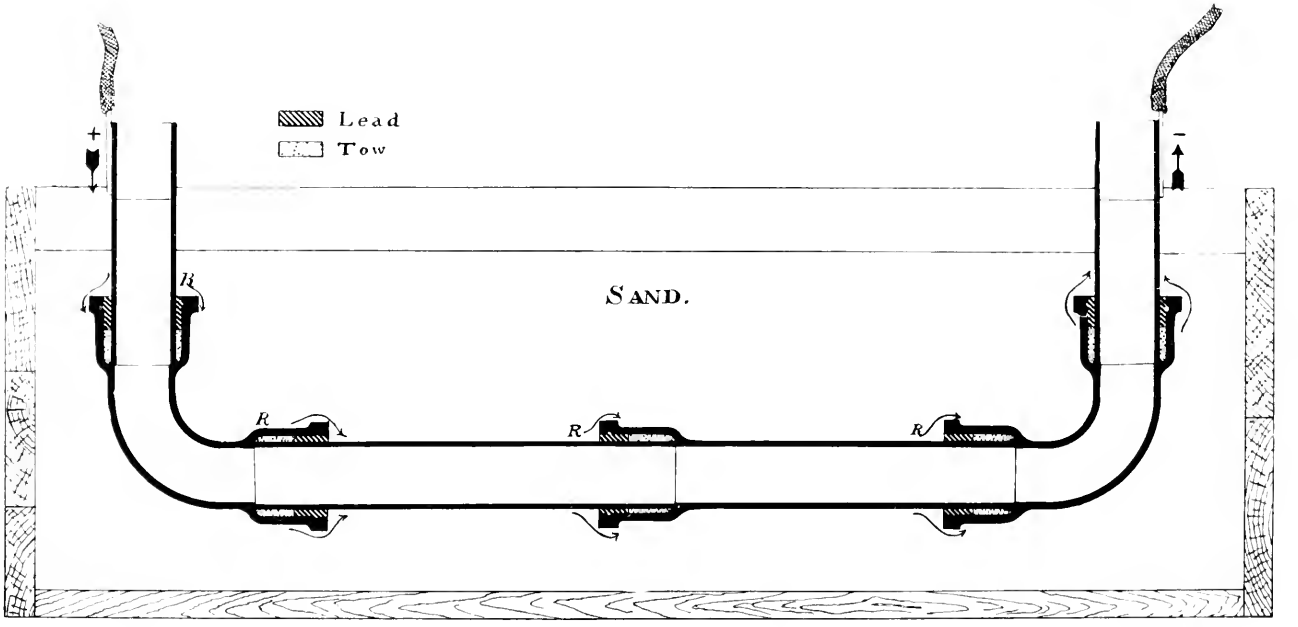
Stone & Webster

PLATE IV.



Stone & Webster.

PLATE V



Stone & Webster.

direction in a city where considerable trouble had been experienced from electrolytic action. This particular piece of pipe was situated at a distance of some two miles from the nearest electric power-station, and it so happened that the tendency of the current was to flow from the adjacent railway system to Section A, and thence to B, in the direction of the power-house. At X there was a rubber gasket, and under the bolt heads were cotton washers, so that Section A was electrically insulated from Section B. This made it necessary for the current to pass from the inner surface of A to the water, and then back again to the surface of B, in order to get around the joint.

When we first noticed the rubber gasket, this condition of affairs was expected; and, upon inspecting the inside of the pipe, it was found that the inner surface of A was covered with scales, and pitted in many places to a depth of 1-16 of an inch, while the inner surface of B was as clean and smooth as upon the day it was first laid.

As the current flowing through this pipe was not large — probably not amounting, on an average, to more than a fraction of an ampere — it seemed probable that in many places trouble might occur even in a leaded bell and spigot joint, where, through corrosion or other cause, the electrical connection was poor; and even to a greater extent in pipes where cement joints were used.

We have shown by experiment that the action of a current flowing through piping with cement joints, as shown by Plate IV., is exactly similar to the action on the joint with the rubber gaskets described above, except that a portion of the current leaves the outside of the pipe and passes through the earth around the joint. This was impossible where the joint came within a manhole, as in the case just mentioned.

It may be well to state, however, in this connection, that where cement joints are used throughout a piping system, the breaks in the electrical continuity are so frequent that the pipes do not act to any great extent as conductors, so that very little current flows.

With regard to lead joints, we have conducted several experiments to determine whether or not an injurious action would be caused if the current flowing through the pipe should be comparatively large.

The first test was conducted on a section of cast-iron pipe, made up with lead joints, as shown in Plate V. This was placed in a box of sand, with the two ends projecting, and filled with water.

A current of 200 amperes entered at the point marked +, and left at point marked —. The current was allowed to pass for about nine hours; then it was shut off for about thirty-six hours; then allowed to flow again for nine hours; and so on. Two hundred amperes was a large current for the size of the pipe, and it was sufficient to heat it perceptibly, especially at the joints.

After this current had flowed for 70 hours, making a total amount of 14,000 ampere hours, the pipe was removed and examined. The inside of the pipe showed no marked corrosion, but the water had become very turbid, indicating electrical action. On the outside the rust was marked at the points R; also, slight rust was present on some other parts.

The rust at the points R is accounted for from the fact that a portion of the current left the pipe at those points and passed around the joint through the moist sand.

This shows that if a large current is flowing longitudinally in an iron pipe, even with good joints, an injurious action is likely to occur at the joints.

Another and quicker method used for showing the same thing was adopted in the following test:

The apparatus for this test consisted of two systems of iron piping, made as in Plate V. Both of these were filled with water and supported by a wooden frame.

A current of about 200 amperes was passed at intervals through one

of the systems of piping. No current was passed through the other; and from time to time samples of water were taken simultaneously from both pipes. In this way we are able to compare the rate at which the water in each pipe became turbid.

The experiment was stopped after 4,700 ampere hours of current had passed. The difference in the samples, while not being striking, was so well marked that there was no mistaking that the pipe with the current passing through was rusting the more rapidly.

From this test it is evident that the flow of an electric current along an iron pipe will increase the rate of decay of the pipe to some extent.

Signs of Electrolytic Action

In carrying on such investigation as this it was at once recognized that it would be of great advantage to be able to note definitely whether the pipes which are submitted to us for inspection have been acted upon electrically, or are simply corroded from natural causes. With this in view, a study of the characteristic appearance, of both lead and iron pipes, when subjected to electrolysis, was undertaken in order to discover, if possible, signs by which the polarity of the pipes could be known in cases where the action had not been sufficiently energetic to produce the well-known pitting marks.

Samples of both lead and iron pipes were obtained for these tests from the Water Department. These pipes had been removed from the streets and were somewhat corroded. Several pairs of each of these were placed in damp sand, and a current of about one ampere was passed from one to another, thus making one pole of each pair positive to the sand and the other negative. This current was maintained for about three weeks during nine hours of each day, and occasional inspections were made, with the following results:

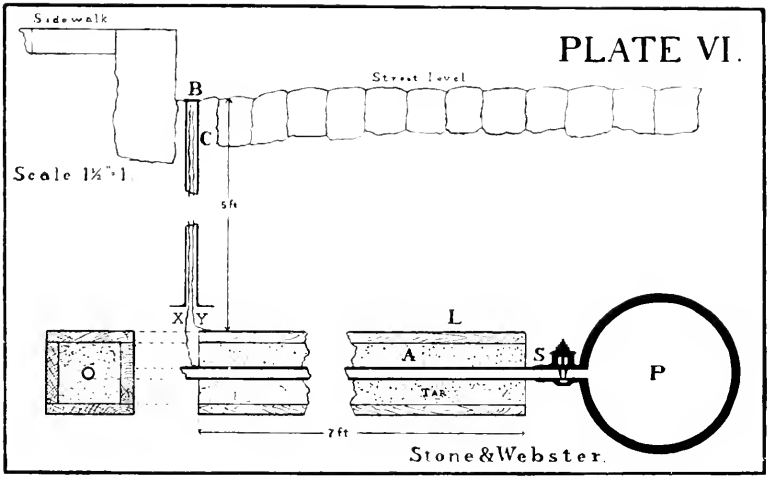
Lead Pipes.

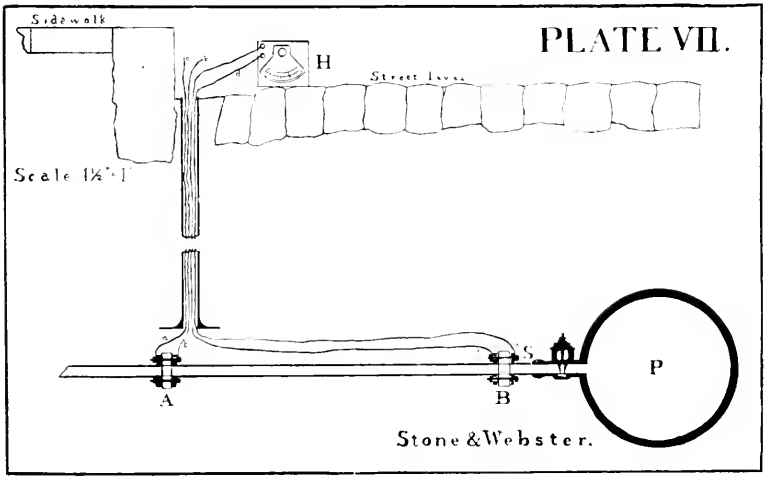
Both pipes of each pair were originally somewhat corroded, and a small amount of scale adhered to the surface. When the positive pipe was taken out and examined after a few days' run, a mass of sand, about a quarter of an inch in thickness, adhered to it; and the particles of this sand were apparently cemented together with black and with salts of lead. Upon scraping off this outside coating of sand, purplish brown salts of lead could be seen adhering to the surface of the pipe, and after current had been passed through the pipe for a sufficient length of time the well-known pit-marks were observed. The negative electrode, when removed from the sand, was clean, of a grayish color, and with little or no sand adhering to it, and of practically the same appearance as a similar pipe buried in sand and entirely free from electrolytic action of any sort.

The above distinctions between the positive and negative electrodes, while not clearly defined in all cases, were sufficiently marked to enable us to determine pretty definitely whether or not a pipe was subjected to electrolytic action, if inspection were made immediately after the pipe was removed from the ground.

Iron Pipes.

In the case of the iron pipes, the indications were less marked. The pipes were originally covered with a fine incrustation of sand, the particles of which were very firmly cemented together. When the pipes were inspected after a few days' run, the only thing observed was that the scale cracked off more easily where electrolytic action had taken place than where no action whatever was present; but there was no clearly defined difference between the negative and positive pipes, and


Sidewalk
PLATE VI.
Street level
B
C
Scale 1½"=1'
5ft
X
Y
L
A
S
P
O
TAR
7ft
Stone&Webster.


Sidewalk
PLATE VII.
C
H
Street level
Scale 1½"=1'
S
P
A
B
Stone&Webster.

as a whole the results obtained were not sufficiently definite to warrant a determination as to whether or not iron pipes which are slightly corroded have been subjected to electrolytic influences.

Rate of Deterioration due to Electrolysis.

In places where electrolytic action is slowly taking place on account of the effect of the return currents from the Street Railway system, it is important to determine as accurately as possible the actual rate of decay due to this cause.

Where the action is marked, occasional inspections will, of course, give a rough idea of this; but in the majority of places throughout the city of Boston deterioration is not taking place rapidly enough to make this practicable, so that it seemed desirable to devise some means of actually determining the rate at which the metal is being taken away from any particular length of pipe. With this in view, the apparatus shown in Plate VI. was devised.

This consists of a wooden box (A) of about 7 feet in length, filled with tar, and placed around the service-pipe (S) beneath the surface of the street. Upon the outside of this box is fastened a sheath of lead (L) whose entire surface is of known relation to the surface of the pipe (S). From the lead sheath, and also from the pipe, wires are led through the tube (C) to a point (B) at the surface of the street, where they are available for connection with an ammeter or voltmeter, as desired.

All flow of current away from the pipe (S) throughout the distance where it is insulated by the box (A), is of course prevented; but if the terminals of the wires at (B) are connected together through an ammeter, the tendency, of course, will be for the current which would naturally leave the pipe (S) to flow up the wire (X) and back by way of the wire (Y) to the lead sheath, and thence from the sheath to the ground.

Several devices of this sort were installed at various places throughout the city and measurements of current taken, but as the apparatus was not put in use until late in the fall, the heavy snows during the winter have prevented satisfactory results.

In other places where we have installed apparatus of this sort, and especially in cities where electrolytic action is taking place at a rapid rate, it has been found that quite reliable measurements as to the quantity of current flowing away from a pipe could be obtained, and as a given quantity of current deposits a certain amount of metal in a given space of time, it has been possible to determine quite accurately the rate at which the pipe submitted to test is undergoing deterioration.

We have recently devised a piece of apparatus, which is illustrated in Plate VII., for obtaining even more satisfactory results than could be obtained from the apparatus illustrated in Plate VI., and if the tests in this city are to be continued, we should advise that devices of this sort be installed at various places through the city, and that frequent measurements of the flow of current be made.

The apparatus consists simply of two insulating joints (A) and (B), with a length of service-pipe, say, ten feet, between them. Wires from each side of each of these insulating joints are carried to the surface of the street. By the insertion of a delicate ammeter between the wires (c) and (d), a measurement of the quantity of current flowing from the main to the service-pipe can be obtained, and if the wires (a) and (b) are left disconnected, this measurement gives approximately the quantity current flowing away from the section (A–B) to the earth, and enables one to determine roughly the rate of deterioration.

By connecting the wires (a and b) together, and leaving the ammeter as shown, connected with wires (c and d) a measurement can be ob-

tained of the quantity of current flowing away from the entire length of service-pipe.

The question will probably be asked whether or not the current flowing through the water in the pipe is not sufficient to vitiate the results, even although an insulated joint in the metal itself is inserted.

In reply to this we would say, that the resistance of the ammeter and leads is so small in comparison with the resistance of the water, that for practical purposes it may be said that all the current flowing from the main into the service pipe will pass through the ammeter (H) and be there recorded.

(Signed) STONE & WEBSTER.

GENERAL CONDITION OF THE WORKS.

The completion of Reservoir No. 6 has increased the daily capacity of the Sudbury and Cochituate supply about 4,000,000 gallons, and the safe capacity of the works in a year of extreme drought is now about 41,500,000 gallons.

As the daily average consumption during the past year was 46,560,000 gallons, it is evident that there is a liability that the supply may be insufficient before Reservoir No. 5 can be completed. The consumption from the Mystic works is now about 11,500,000 gallons per day, an amount far in excess of their capacity. Even during the past year, which was not exceptionally dry, 40,000 people in the Charlestown district were supplied from the Cochituate works for nearly four months, and Mystic lake was drawn to such a low point by the temporary pumps that the quality of the water was affected by the infiltration of salt water from the Lower Mystic lake.

Although the completion of Reservoir No. 5 will raise the safe total capacity of all the sources of supply to 61,500,000 gallons per day, it is evident that the daily consumption, which is now about 57,000,000 gallons, will soon be in excess of the yield of our sources of supply.

Another consideration is the question of the necessity of abandoning the Mystic supply on account of the difficulty in preserving the purity of the water. The annual reports for the past fifteen years have reiterated the statement that the quality of the water from this source is constantly deteriorating, and that it is not practicable, on account of the large population residing on the water-shed, to make any permanent improvement in the quality. As the Mystic supply cannot be abandoned until an additional supply is obtained, and as the construction of Reservoir No. 5 will complete the development of the Sudbury-river supply, it is evident that immediate steps should be taken to procure an additional supply sufficient to meet the requirements of the city for future years.

In consequence of the great increase in the high-service consumption the supply mains from Fisher Hill Reservoir and in the Roxbury District are inadequate to furnish a supply without an excessive loss of head. At times the Parker Hill Reservoir has been nearly emptied, and residents on the higher land have been entirely deprived of their supply.

To remedy this difficulty the laying of a 48-inch main has been recommended from the junction of Fisher Hill avenue and Boylston street to the corner of Huntington avenue and Heath street. At this point the main will be divided, a 12-inch main continuing through Huntington avenue and Boylston street for the supply of the city proper, with a connection at Wait street for the supply of Parker Hill Reservoir; the other branch, 36 inches in diameter, to be carried through Heath street and across the Roxbury district.

The new pumping-engines at the Chestnut Hill and Mystic stations will furnish sufficient pumping capacity to meet the requirements at those stations for the next five years.

At the East Boston station all of the pumps are in need of repairs, and a new pump should be purchased for the use of the Breed's Island service.

The relaying of the old tuberculated mains with pipes of larger size and the laying of new supply mains has not kept pace with the growth of the city for the past few years. About 10 miles of the new and enlarged mains which have been recommended to your Board since 1891 still remain to be laid, and I recommend that the work be pushed as fast as possible. From three to four miles of the old 4-inch and 6-inch pipe and from 100 to 200 of the old pattern Boston hydrants should be replaced each year, to meet the demands for better fire protection.

Appended to this report will be found the usual tables of rainfall, consumption, etc., for the past year, and in addition, tables are given of the rainfall, rainfall collected, and percentage collected on the Cochituate water-shed since 1863, on the Sudbury-river water-shed since 1875, and on the Mystic water-shed since 1878. These will be found valuable for future reference.

TABLE I.

Daily Average Consumption of Water, in Gallons, from the Cochituate and Mystic Works.

Month.	Cochituate Works.							Mystic Works.						
	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
January	40,485,700	30,172,000	33,680,000	37,230,100	36,756,400	53,847,100	48,395,000	11,107,100	7,769,500	8,187,900	9,389,300	9,878,200	14,129,700	11,823,500
February	43,105,000	35,855,200	33,030,700	37,280,700	38,881,500	51,299,400	49,207,500	11,620,900	9,073,600	8,299,700	9,466,900	10,332,200	13,174,700	12,295,000
March	36,463,400	32,180,000	30,844,400	35,533,400	38,395,100	48,700,200	44,844,300	9,242,000	7,537,600	8,055,800	8,811,000	9,970,500	11,692,700	10,720,800
April	31,473,800	30,814,500	30,446,600	35,751,600	37,171,000	45,573,100	40,070,200	7,276,700	7,185,700	7,481,600	8,045,800	9,145,000	9,812,500	10,236,200
May	30,802,000	32,719,500	31,381,200	36,580,700	37,055,900	43,451,500	41,827,700	6,932,300	7,663,600	7,488,400	8,841,300	9,204,900	9,817,400	10,661,000
June	31,926,100	33,377,900	33,022,700	37,801,900	41,564,000	44,125,100	45,906,400	7,615,200	8,017,700	8,396,000	9,478,400	10,146,300	[1]10,460,000	12,552,300
July	32,014,400	31,870,300	36,701,100	39,062,600	45,738,100	48,986,900	50,044,000	8,267,500	8,315,600	9,463,300	9,581,700	10,702,900	[1]10,167,000	12,172,000
August	32,432,700	31,403,200	36,316,900	39,460,400	45,631,600	48,062,000	47,288,500	7,859,100	8,113,200	8,932,200	9,122,300	9,751,500	9,826,200	10,696,700
September	31,836,500	31,722,800	36,165,800	40,677,700	45,261,900	46,926,500	[2]48,558,700	7,266,300	7,966,000	8,436,700	9,128,700	9,549,400	9,115,600	[2]8,703,600
October	29,110,800	31,702,200	33,429,800	38,884,600	44,626,700	46,416,600	47,072,500	7,096,400	7,627,500	7,784,100	9,259,100	9,340,500	9,630,400	7,421,200
November	28,590,900	31,539,400	32,955,100	36,640,800	41,347,800	44,328,900	47,101,500	6,990,800	7,316,700	7,601,300	8,585,200	9,230,000	9,569,700	7,563,100
December	32,686,200	31,829,000	38,334,100	37,342,500	43,766,400	47,807,800	48,511,600	7,918,600	7,473,200	9,448,300	8,960,600	10,473,700	11,620,800	8,667,800
Yearly average	33,310,700	32,070,000	33,871,700	37,686,900	41,312,400	47,453,200	46,560,000	8,258,400	7,830,500	8,301,400	9,055,200	9,810,800	10,742,500	10,282,100

[1] From June 7 to July 29 about 3,000,000 gallons per day were wasted from a blow-off.
[2] After September 12, Charlestown was supplied with Cochituate water.

BOSTON WATER WORKS.

Diagram showing the rainfall and daily average Consumption for each month.

Yearly Averages shown thus - - - - -

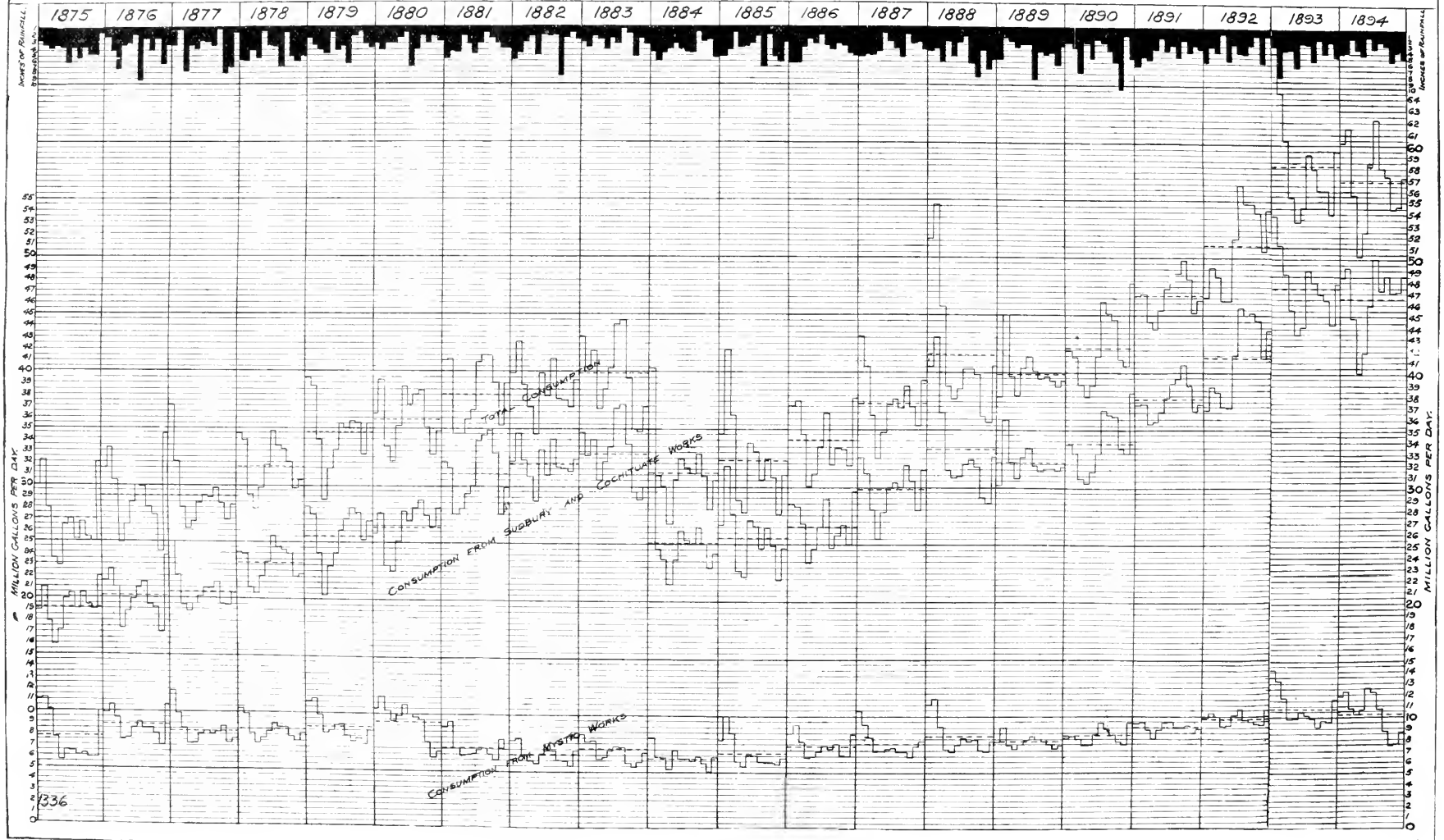


TABLE 11.

Diversion of Sudbury-River Water, 1887–1894.

Month.	1887.	1888.	1889.		1890.	1891.	1892.		1893.	1894.	
	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Lake Cochituate.	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Lake Cochituate.	To Chestnut Hill Res'r.	To Chestnut Hill Res'r.	To Lake Cochituate.	To Chestnut Hill Res'r.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
January	692,200,000	895,400,000	. . . .	484,500,000	518,600,000	715,000,000	. . . .	630,800,000	1,325,900,000	. . . .	1,012,000,000
February	472,000,000	906,700,000	. . . .	564,600,000	475,000,000	560,800,000	. . . .	610,400,000	957,600,000	. . . .	944,000,000
March	456,700,000	691,400,000	. . . .	584,500,000	498,600,000	573,200,000	45,100,000	625,200,000	1,023,300,000	529,100,000	947,100,000
April	385,400,000	468,800,000	. . . .	400,500,000	417,000,000	641,900,000	545,000,000	662,500,000	917,000,000	134,100,000	725,600,000
May	444,200,000	566,300,000	233,400,000	615,700,000	536,300,000	740,300,000	114,700,000	690,400,000	858,500,000	215,800,000	826,500,000
June	463,600,000	489,000,000	. . . .	567,600,000	513,100,000	629,500,000	197,500,000	779,300,000	856,700,000	80,700,000	875,500,000
July	387,500,000	528,900,000	. . . .	534,000,000	664,100,000	755,100,000	. . . .	948,000,000	1,040,800,000	. . . .	1,164,600,000
August	352,800,000	626,700,000	. . . .	443,700,000	625,500,000	722,900,000	. . . .	897,700,000	994,100,000	. . . .	951,600,000
September	377,300,000	581,500,000	. . . .	475,500,000	606,400,000	732,400,000	. . . .	876,300,000	948,300,000	. . . .	987,100,000
October	672,300,000	435,900,000	. . . .	414,100,000	539,900,000	715,300,000	. . . .	908,500,000	956,800,000	1,100,000	958,500,000
November	607,100,000	410,900,000	. . . .	454,600,000	526,000,000	752,200,000	. . . .	788,000,000	862,700,000	400,000	1,021,000,000
December	703,000,000	505,200,000	. . . .	501,200,000	675,500,000	767,100,000	. . . .	1,216,100,000	935,700,000	1,000,000	1,137,100,000
Totals	6,124,100,000	7,224,700,000	233,400,000	6,130,500,000	6,596,000,000	8,306,000,000	902,300,000	9,633,200,000	11,737,900,000	962,200,000	11,450,600,000
Total diversion from Sudbury river.	6,124,100,000	7,224,700,000	6,363,900,000		6,596,000,000	8,306,000,000	10,535,500,000		11,737,900,000	12,412,800,000	
Average daily diversion for whole year.	16,778,400	19,739,600	17,435,300		18,071,200	22,757,800	28,800,000		32,158,600	34,007,700	

TABLE III.

Statement showing Amount of Water drawn from Lake Cochituate; Amount wasted; Amount of Rainfall collected in Lake; Amount received into Lake from Sudbury River; Percentage of Rainfall collected, etc., 1852 to 1894; Water-shed of Lake, 12.077 Acres.

Year.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Amount received into Lake from Sudbury River.	Storage.		Total Amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1852[1]	2,974,042,800	4,020,566,900			261,360,000	6,733,249,700	18,396,900	47.93	20.01	43.
1854	3,117,939,500	3,166,417,500		230,580,000		6,523,937,000	17,873,800	55.73	19.51	35.
1854	3,614,230,000	4,187,733,000			217,800,000	7,584,163,000	20,778,500	43 15	22.87	53.
1855	3,776,389,500	No account kept			326,700,000			34.93		
1856	4,409,787,000	"		598,950,000				40.80		
1857	4,644,000,000	10,625,000,000		32,670,000		15,303,360,000	41,927,600	62.10	45.69	74.
1858	4,689,155,000	1,934,500,000			141,570,000	6,482,085,000	17,759,000	48.56	19.46	40.
1859[2]	4,808,875,000	7,560,000,000		283,140,000		12,661,015,000	34,687,700	49.02	38.24	78.
1860	6,300,108,000	None.		174,240,000		6,483,348,000	17,714,100	55.44	19.49	35.
1861	6,639,005,000	3,377,559,000			1,459,260,000	8,557,394,000	23,444,900	45.44	25.45	56.
1862	6,959,040,000	33,200,000		1,306,800,000		7,399,000,000	20,271,200	43.69	22.36	45.
1863	5,927,052,500	2,165,696,500		763,300,000		8,855,049,000	24,260,400	69.30	26.88	39.
1864	6,105,396,700	1,368,746,000			1,848,577,000	5,625,475,700	15,370,200	42.60	18.35	43.
1865	4,021,630,000	1,688,120,700		743,242,500		7,052,993,200	19,323,300	49.46	20.50	41.
1866	4,463,585,000	None.		743,242,500		5,206,827,500	14,265,300	62.32	16.01	26.
1867	4,951,225,000	2,482,041,000			698,811,000	6,734,455,000	18,450,600	56.25	21.80	39.
1868	5,405,515,000	2,507,684,000		346,371,000		8,259,570,000	22,567,200	49.71	24.98	50.
1869	5,503,751,000	1,635,570,000		480,882,000		7,620,203,000	20,877,300	64.34	21.99	34.
1870	5,477,810,900	4,818,971,000			1,736,085,000	8,560,696,000	23,453,900	55.89	26.08	47.

1871	5,223,500,000	None.	. . . . .	. . . . .	250,933,000	4,972,567,000	13,623,500	45.39	15.16	33.
1872	5,775,151,200	None.	1,676,666,400	1,543,995,500	. . . . .	5,642,480,300	15,416,600	48.47	17.22	35.
1873	6,511,826,900	2,917,977,000	. . . . .	. . . . .	515,132,000	8,914,671,900	24,423,800	45.43	27.13	60.
1874	6,623,972,900	1,145,851,700	. . . . .	. . . . .	1,367,715,000	6,402,109,600	17,540,000	35.93	19.52	54.
1875	7,092,955,500	None.	2,555,800,000	1,222,885,000	. . . . .	5,760,040,500	15,780,900	45.49	17.57	39.
1876	7,277,175,200	1,619,243,800	2,528,300,000	43,438,000	. . . . .	6,411,557,000	17,517,900	48.49	19.54	40.
1877	7,626,889,200	1,484,978,600	1,894,350,000	378,727,000	. . . . .	7,596,244,800	20,811,600	43.80	23.17	53.
1878	7,743,904,700	3,341,875,000	2,668,300,000	219,789,000	. . . . .	8,637,268,700	23,663,700	53.58	26.34	49.
1879	6,051,838,900	1,523,361,400	411,300,000	. . . . .	1,322,697,300	5,841,203,000	16,003,300	38.01	17.81	47.
1880	4,284,147,100	65,577,700	826,700,000	. . . . .	146,265,000	3,376,759,800	9,226,100	35.83	10.30	29.
1881	2,846,459,700	2,231,016,700	187,600,000	468,089,400	. . . . .	5,357,965,800	14,679,400	41.09	16.34	40.
1882	3,935,490,600	1,358,543,700	. . . . .	. . . . .	357,334,700	4,936,699,600	13,525,200	40.29	15.05	37.
1883	4,731,227,700	162,361,800	1,245,100,000	. . . . .	334,400,000	3,314,089,500	9,079,700	31.20	10.11	32.
1884	4,533,156,450	1,842,837,100	1,116,300,000	1,340,436,700	. . . . .	6,300,130,250	17,213,450	45.57	19.21	42.
1885	4,091,674,900	1,006,622,800	. . . . .	8,594,800	. . . . .	5,106,892,500	13,991,500	43.66	15.57	36.
1886	4,432,536,100	3,116,283,200	. . . . .	. . . . .	360,662,000	7,188,157,300	19,693,600	46.97	21.92	47.
1887	4,802,120,700	3,658,652,900	. . . . .	. . . . .	763,205,000	7,697,568,600	21,089,200	41.58	23.47	56.
1888	4,968,503,100	4,229,200,000	. . . . .	959,309,000	. . . . .	10,157,012,100	27,751,400	56.93	30.97	54.
1889	5,570,423,600	3,373,929,000	233,400,000	454,766,800	. . . . .	9,165,719,400	25,111,600	50.23	27.95	56.
1890	5,722,170,800	2,380,441,200	. . . . .	. . . . .	64,166,300	8,038,445,700	22,023,100	51.23	24.51	48.
1891	5,508,178,900	6,064,000,000	. . . . .	. . . . .	1,056,057,800	10,516,121,100	28,811,300	46.42	32.07	69.
1892	5,464,791,300	281,000,000	902,300,000	200,284,300	. . . . .	5,033,775,600	13,753,500	39.01	15.35	39.
1893	5,623,532,500	255,300,000	. . . . .	. . . . .	89,200,000	5,789,632,500	15,862,000	45.28	17.65	39.
1894	5,520,092,100	None.	962,200,000	. . . . .	296,900,000	4,260,992,100	11,674,000	39.08	12.99	33.
Averages . . .	5,243,260,900	2,283,921,000	. . . . .	. . . . .	. . . . .	7,123,442,100	19,504,600	47.51	21.66	45.0

[1] Observations of rainfall at Lake Cochituate commenced 1852, and these observations are assumed as correct for the whole district.
[2] Lake raised two feet.

TABLE IV.

Statement showing Amount of Water Diverted from Sudbury River to Lake Cochituate and Chestnut Hill Reservoir; Amount wasted; Amount of Flow in River; Percentage of Rainfall Collected, etc., 1875 to 1894.

(Water-shed from 1875 to 1878, inclusive, = 77.764 sq. miles; in 1879 and 1880 = 78.238 sq. miles; and from 1881 to 1893, inclusive, = 75.2 sq. miles.)

Year.	Amount of Water diverted to Lake Cochituate and Chestnut Hill Reservoir.	Amount of Water used by Framingham Water Co.	Amount of Water wasted from River.	Storage.		Total amount of flow in River.	Daily average amount of flow in River.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1875	2,555,800,000		24,971,600,000	66,300,000		27,593,700,000	75,599,200	45.490	20.418	44.88
1876	2,528,300,000		29,942,300,000		160,700,000	32,309,900,000	88,278,400	49.563	23.908	48.24
1877	1,894,350,000		32,438,300,000	112,100,000		34,444,750,000	94,369,200	44.018	25.847	57.90
1878	3,422,100,000		37,125,200,000	654,700,000		41,202,000,000	112,882,200	57.931	30.487	52.63
1879	3,749,200,000		20,817,500,000	962,200,000		25,528,900,000	69,942,200	41.419	18.775	45.33
1880	6,230,200,000		11,290,000,000		958,600,000	16,561,600,000	42,250,300	38.177	12.182	31.91
1881	8,845,300,000		17,279,000,000	751,700,000		26,876,000,000	73,633,900	44.169	20.565	46.56
1882	7,735,200,000		16,273,900,000		352,600,000	23,656,600,000	64,812,300	39.394	18.102	45.95
1883	8,455,000,000		7,251,900,000		1,086,400,000	14,620,500,000	40,056,200	32.780	11.188	34.13
1884	6,110,600,000		23,228,900,000	1,744,600,000		31,084,100,000	84,929,200	47.135	23.784	50.46
1885	5,224,700,000	61,800,000	19,878,800,000		446,900,000	24,718,400,000	67,721,600	43.545	18.916	43.44
1886	5,266,600,000	76,600,000	23,023,000,000	1,464,500,000		29,831,700,000	81,730,700	46.065	22.825	49.55
1887	6,124,100,000	87,500,000	25,334,500,000	117,400,000		31,663,500,000	86,749,300	42.705	24.227	56.73
1888	7,224,700,000	61,500,000	39,040,500,000	390,600,000		46,717,300,000	127,642,900	57.465	35.749	62.21

1889	6,363,900,000	59,500,000	31,550,400,000	. . . . .	2,800,000	37,971,000,000	104,030,100	49.95	29.056	58.17
1890	6,596,000,000	74,500,000	28,667,100,000	. . . . .	57,400,000	35,280,200,000	96,658,100	53.00	26.998	50.94
1891	8,306,600,000	80,500,000	28,799,600,000	. . . . .	1,100,800,000	36,085,900,000	98,865,500	49.52	27.612	55.76
1892	10,535,500,000	82,800,000	11,143,000,000	. . . . .	257,700,000	21,503,600,000	58,753,000	41.83	16.456	39.34
1893	11,737,900,000	103,000,000	17,405,500,000	. . . . .	789,800,000	28,456,600,000	77,963,300	48.225	21.774	45.15
1894	12,412,800,000	117,000,000	6,715,900,000	1,901,600,000	. . . . .	21,147,300,000	57,937,800	39.740	16.182	40.72
Averages .	6,565,992,500	80,470,000	22,608,705,000	. . . . .	. . . . .	29,362,532,500	80,239,900	45.606	22.234	48.00

TABLE V.

Statement showing Amount of Water drawn from Mystic Lake; Amount wasted; Amount of Rainfall collected in Lake; Percentage of Rainfall collected, etc., 1876 to 1894; Water-shed of Lake, 17,200 Acres.

YEAR.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	STORAGE.		Total Amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
			Gain.	Loss.					
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1876	3,230,101,300	6,369,774,700		32,583,000	9,567,293,000	26,140,100	47.00	20.49	43.6
1877	3,069,554,800	7,250,223,500		16,291,400	10,303,486,900	28,228,700	43.095	22.06	51.2
1878	3,367,490,400	8,718,547,600		26,000,000	12,060,038,000	33,041,200	54.065	25.82	47.8
1879	3,490,848,200	4,625,691,800		203,000,000	7,913,540,000	21,680,900	35.30	16.94	48.0
1880	3,692,195,700	2,158,761,200		113,500,000	5,703,756,900	15,584,000	34.42	12.21	35.5
1881	2,815,579,900	5,534,300,000	371,200,000		8,721,079,900	23,893,400	41.91	18.67	44.5
1882	2,570,896,700	4,444,668,000	15,000,000		7,030,564,700	19,261,800	39.165	15 05	38.4
1883	2,664,514,200	2,034,702,600		347,579,000	4,351,637,800	11,922,300	31.22	9.32	29.84
1884	2,469,761,000	6,574,003,800	380,600,000		9,424,364,800	25,749,600	44.39	20.18	45.46
1885	2,639,278,800	5,558,860,500		33,200,000	8,194,939,300	22,451,900	44.50	17.55	39.43
1886	2,862,947,500	7,743,258,900		28,400,000	10,577,806,400	28,980,300	45.56	22.65	49.71
1887	2,954,257,500	7,414,213,000		11,000,000	10,357,470,500	28,376,600	46.42	22.17	47.77
1888	3,205,121,100	11,334,593,100		6,000,000	14,533,714,200	39,709,600	56.745	31.12	54.84
1889	3,007,539,800	8,879,787,500	12,000,000		11,899,327,300	32,600,900	50.395	25.48	50.56
1890	3,212,284,500	8,953,727,900		3,000,000	12,163,012,400	33,323,300	49.37	26.04	52.75
1891	3,500,817,500	10,027,714,400		171,000,000	13,357,531,900	36,600,000	47.40	28.60	60.34
1892	3,811,766,200	3,474,213,200	177,000,000		7,462,979,400	20,390,700	39.115	15.98	40.85
1893	4,331,743,200	4,958,528,500		95,000,000	9,195,271,700	25,192,500	44.20	19.69	44.54
1894	3,996,805,100	2,752,964,200		23,000,000	6,726,769,300	18,429,500	39.24	14.40	36.70
Average	3,204,921,200	6,254,659,700			9,449,715,000	25,871,200	43.89	20.23	45.36

TABLE VI.

Average Maximum and Minimum Monthly and Yearly Heights, in Feet, above Tide Marsh Level to which Water would rise at Different Stations on the Boston Water-Works.

1894.	Boston Common.		Engine-house No. 8, Salem street.		Engine-house No. 7, East street.		Engine-house No. 38, Congress street, South Boston.		Engine-house No. 2, Fourth street, South Boston.		Engine-house No. 9, Paris street, East Boston.		Engine-house No. 16, River street, Dorchester.		Engine-house No. 32, Bunker Hill street, Charlestown, Mystic Supply.		710 Albany street.		City Hall, High Service.		Engine-house No. 18, Harvard street, Dorchester, High service.		Engine-house No. 24, Warren street, Roxbury, High Service.	
Month.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*
January. .	118.6	103.1	116.2	98.8	116.8	101.3	114.6	96.5	116.6	96.5	109.1	82.6	116.7	98.9	140.5	125.7	116.8	101.9	217.9	204.4	. .	. .	. .	. .
February .	115.9	100.4	113.9	95.9	115.6	99.5	112.9	94.4	114.2	93.9	103.5	77.4	114.5	96.2	139.4	124.8	115.1	100.2	218.5	205.1	. .	. .	. .	. .
March . .	117.9	102.1	117.5	99.3	119.2	102 4	117.1	96.9	115.6	94.0	110.3	82.5	119.2	100.3	144.4	126.5	118.3	102.9	220.6	205.4	. .	. .	. .	. .
April . . .	119.6	103.0	119.6	101.1	120.4	103.8	119.0	98.4	117.7	95.8	111.9	80.3	120.6	99.9	145.0	127.6	120.0	104.0	220.8	205.6	. .	. .	. .	. .
May . . .	120.0	102.5	119.9	100.5	120.9	103.6	119.1	97.5	118.1	93.5	113.2	76.3	121.2	99.7	145.7	127.2	119.9	103.7	221.0	205.6	. .	. .	. .	. .
June . . .	119.9	102.6	119.7	100.1	120.8	102.6	118.0	94.7	117.5	91 2	110.3	72.0	120.3	95.0	143.8	120.6	119.9	102.6	217.5	201.5	. .	. .	. .	. .
July . . .	118.8	99.8	118.5	97.3	119.6	100.7	116.4	92.2	116.0	89.6	111.2	76.7	118.2	93.6	144.3	123.1	118.4	100.7	216.2	201.6	215.3	181.1	. .	. .
August . .	118.8	101.5	118.4	98.7	119.7	103.0	116.4	94.6	115.7	91.5	109.9	77.2	117.9	95.7	143.2	124.8	119.3	102.3	220.6	205.7	219.6	191.9	222.1	200.0
September,	118.2	99.4	117.6	96.7	119.6	102.5	117.0	95.3	115.3	90.4	110.4	76.9	117.1	93.8	{ 140.2 [1] 115.5	{ 122.4 89.5	119.0	101.1	216.5	201.5	215.7	191.0	217.2	198.2
October . .	118.4	98.9	117.8	95.3	119.3	100.6	117.6	97.5	116.6	91.7	110.7	77.9	117.7	96.1	116.2	89.7	119.1	100.6	215.0	198.0	214.9	192.8	216.2	199.3
November .	117.5	99.2	117.1	95.5	118.2	100.2	117.1	92.2	115.3	92.8	109.4	78.9	117.2	96.7	115.1	89.9	118.6	100.7	217.7	202.1	217.5	198.4	219.1	204.4
December	115.4	97.6	114.7	93.8	116.1	98.4	114.3	95.1	111.8	89.8	104.8	75.3	115.1	95.5	111.9	87.8	116.4	100.0	215.7	199.1	214.6	196.4	217.4	203.2
Averages	118.2	100.9	117.6	97.7	118.9	101.5	116.6	95.4	115.9	92.6	109.5	77.8	118.0	96.8	. . .	. . .	118.4	101.7	218.3	202.9	216.3	191.9	218.4	201.0

[1] On September 12 Mystic supply was shut off from Charlestown and Cochituate turned on.

TABLE VII.

Statement of Operations at the Chestnut Hill Pumping-Station for 1894.

1894.	Engine No. 1.			Engine No. 2.			Total amount pumped, 2% allowed for slip.	Daily average amount pumped.	Total amount of coal consumed.	Daily average amount of coal consumed.	Total ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per lb. of coal. No correction for heating and lighting.	Quantity pumped per lb. of coal. Corrected for heating and lighting.	Average lift in feet.	Division of Coal.			Duty in ft.-lbs. per 100 lbs. of coal.		Water evaporated in boilers per lb. of coal.	
	Total pumping time.		Amount pumped.	Total pumping time.		Amount pumped.										Heating.	Lighting.	Pumping.	Without correction for heating and lighting.	Corrected for heating and lighting.	Actual.	From and at 212° F., including feed-water heater.
Month.	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Lbs.*	*Lbs.*	*Lbs.*	*Per cent.*	*Gals.*	*Gals.*	*Feet.*	*Lbs.*	*Lbs.*	*Lbs.*	*Ft.-Lbs.*	*Ft.-Lbs.*	*Lbs.*	*Lbs.*
January .	2	.	792,075	737	05	298,553,275	299,345,350	9,656,300	388,775	12,541	28,438	7.3	770.0	847.3	124.91	12,779	22,721	353,275	80,211,700	88,272,000	9.84	11.64
February,	665	35	282,123,250	.	.	. . . . .	282,123,250	10,075,800	354,025	12,644	24,868	7.0	796.9	872.7	124.17	11,576	19,188	323,261	82,525,400	90,379,200	9.69	11.45
March . .	11	30	4,724,720	739	15	298,065,640	302,790,360	9,767,400	381,983	12,322	27,019	7.1	792.7	860.6	125.45	10,871	19,775	351,837	82,934,400	90,040,400	10.34	12.20
April . .	717	55	297,644,675	.	.	. . . . .	297,644,675	9,921,500	354,474	11,816	23,927	6.8	839.7	904.0	125.29	8,332	16,871	329,271	87,739,700	94,455,500	10.19	11.97
May . . .	141	05	60,014,800	624	10	255,902,175	315,916,975	10,190,900	365,959	11,805	25,286	6.9	863.3	900.4	[1]125.90	. . .	15,083	350,876	90,642,600	94,539,000	10.30	12.02
June . . .	717	30	306,151,000	78	25	28,039,750	334,190,750	11,139,700	379,723	12,657	26,697	7.0	880.1	912.8	[1]126.63	. . .	13,617	366,106	92,945,900	96,403,000	10.03	11.64
July . . .	247	05	98,468,050	597	.	249,645,225	348,113,275	11,229,500	405,447	13,079	28,942	7.1	858.6	891.2	[1]127.94	. . .	14,850	390,597	91,613,400	95,096,400	9.94	11.47
August. .	266	25	113,365,550	474	50	203,696,025	317,061,575	10,227,800	362,980	11,709	28,234	7.8	873.5	915.7	126.96	. . .	16,733	346,247	92,489,800	96,959,600	10.20	11.76
September,	432	20	185,666,510	323	15	136,674,975	322,341,485	10,744,700	374,788	12,493	28,354	7.6	860.1	901.8	[1]127.26	. . .	17,333	357,455	91,282,700	95,709,000	10.13	11.73
October. .	451	10	191,488,925	357	50	150,680,100	342,169,025	11,037,700	407,821	13,156	33,791	8.3	839.0	897.3	[1]127.62	6,851	19,617	381,353	89,300,900	95,498,900	9.79	11.43
November,	447	50	193,359,225	273	30	116,488,125	309,847,350	10,328,200	402,095	13,403	30,980	7.7	770.6	856.8	[1]126.61	18,272	22,192	361,631	81,367,900	90,472,400	9.59	11.27
December,	301	30	131,114,225	437	.	189,316,250	[2]324,286,525	10,460,900	[3]459,590	14,825	[4]33,030	[4]7.6	705.6	792.9	[1]125.39	25,077	25,500	[3]409,013	76,620,300	86,639,900	8.85	10.47
Totals and averages,	4401	55	1,864,913,005	4642	20	1,927,061,540	3,795,830,595	10,399,500	4,637,660	12,706	339,566	7.4	818.5	878.5	126.18	93,258	223,480	4,320,922	86,459,300	92,829,900	9.89	11.47

[1] For several days during the month, Engines Nos. 1 and 2 were run simultaneously for a few hours.
[2] Including 3,856,050 gallons pumped by Engine No. 3.
[3] Including 22,250 pounds burned under Boiler No. 4.
[4] From old boilers only (Nos. 1, 2, and 3).

TABLE VIII.

Statement of Operations at the Mystic Pumping-Station for 1894.

1894.	Engine No. 1.			Engine No. 2.			Engine No. 3.			Total amount pumped.	Daily average amount pumped.	Daily average amount of coal consumed.	Daily average amount of ashes and clinkers.	Per cent ashes and clinkers.	Quantity pumped per pound of coal.	Average lift in feet.	Duty in foot-pounds per 100 pounds of total coal.
	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.								
Month.	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Lbs.*	*Lbs.*	*Per ct.*	*Gals.*	*Feet.*	*Foot-pounds.*
January	. . .	. . .	. . . . .	578	30	119,909,100	734	00	246,604,800	366,513,900	11,826,900	27,097	2,935	10.8	436.3	148.78	54,110,400
February	58	00	12,487,700	477	45	98,467,100	672	00	233,190,400	344,145,200	12,290,900	27,536	2,760	10.0	446.4	147.75	55,002,300
March	185	15	42,642,400	171	45	36,209,800	743	00	253,491,200	332,343,400	10,720,800	24,484	2,813	11.5	437.9	147.56	53,886,500
April	. . .	. . .	. . . . .	342	15	68,644,600	719	00	238,412,800	307,057,400	10,235,200	23,467	2,335	10.0	436.2	147.50	53,654,400
May	343	00	75,182,900	497	15	103,087,700	453	00	152,089,600	330,360,200	10,656,800	25,000	2,631	10.5	426.3	147.29	52,367,100
June	623	15	139,342,800	. . .	. . .	. . . . .	717	30	237,516,800	376,859,600	12,562,000	29,033	3,287	11.3	432.7	149.10	53,892,800
July	625	20	138,316,000	5	30	1,072,100	737	00	237,900,800	377,288,900	12,170,600	27,677	2,897	10.5	439.7	150.09	55,043,300
August	400	30	84,952,600	. . .	. . .	. . . . .	721	30	236,595,200	321,547,800	10,372,500	23,839	2,899	12.2	435.1	150.28	54,534,100
September	354	45	78,187,800	19	30	3,911,100	561	15	188,825,600	270,054,500	9,031,800	21,400	2,686	12.6	422.1	150.25	52,886,200
October	33	45	7,942,600	6	15	1,192,900	695	00	220,748,800	229,884,300	7,415,600	16,516	2,055	12.4	449.0	148.95	55,775,800
November	33	15	5,873,600	. . .	. . .	. . . . .	696	00	220,672,000	226,545,600	7,551,500	17,733	2,133	12.0	425.8	148.60	52,807,100
December	680	45	147,013,600	468	15	99,297,630	66	00	21,606,400	267,917,600	8,642,500	24,542	2,707	11.0	352.2	147.16	[1] 43,220,200
Totals and averages,	3,337	00	751,942,300	2,585	00	531,822,000	7,518	15	2,487,654,400	3,751,418,700	10,277,900	24,010	2,678	11.2	428.1	148.62	53,057,500

[1] Steam used in pumping water from excavation for foundation of new engine.

TABLE IX.

Statement of Operations at the East Boston Pumping-Station for the Year 1894.

1894.	Engine No. 2.				Engine No. 3.				Total amount of coal consumed.	Per cent. of ashes and clinkers.
	Total pumping time.		Total amount pumped to reservoir.	Daily average.	Total pumping time.		Total amount pumped to tank.	Daily average.		
Month.	*Hrs.*	*M.*	*Gallons.*	*Gallons*	*Hrs.*	*M.*	*Gallons.*	*Gallons*	*Pounds.*	*Per ct.*
Jan. .	276	50	11,362,540	366,500	56	50	787,020	25,400	30,800	19.1
Feb. .	276	05	11,847,640	423,100	55	20	793,440	28,300	32,960	18.7
March,	266	25	11,453,960	369,500	63	15	915,000	29,500	30,740	18.9
April .	297	55	12,327,140	410,900	64	40	925,080	30,800	34,260	18.7
May .	269	00	10,921,820	352,300	64	20	912,240	29,400	30,040	18.8
June .	255	25	10,538,080	351,300	80	25	1,119,660	37,300	31,960	18.9
July .	292	50	12,422,060	400,700	88	00	1,275,840	41,200	34,310	18.7
Aug. .	283	50	12,034,120	388,200	68	50	973,860	31,400	32,550	18.7
Sept. .	264	10	11,154,220	371,800	64	05	940,500	31,400	30,370	18.9
Oct. .	309	25	12,709,900	410,000	60	15	891,060	28,700	34,200	18.7
Nov. .	293	20	11,637,360	387,900	57	20	812,160	27,100	32,400	19.0
Dec. .	313	50	12,123,160	391,100	62	00	900,240	29,000	36,050	19.1
Totals,	3,399	05	140,532,000	385,000	785	20	11,246,100	30,800	390,640	18.9

Note. — Engine No. 1 was not run during 1894.

TABLE X.

Statement of Operations at the West Roxbury Pumping-Station for the Year 1894.

1894.	Total pumping time.		Total amount pumped.	Daily average amount pumped.	Quantity pumped per lb. of coal.	Total amount of coal consumed.	Per cent of ashes and clinkers.	Average lift.
Month.	*Hours.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Pounds.*	*Per cent.*	*Feet.*
January . .	275	00	3,229,275	104,200	139.8	23,100	20.3	136.26
February .	253	30	3,198,000	114,200	140.6	22,750	20.0	135.82
March . . .	259	30	3,152,400	101,700	138.9	22,700	20.4	136.36
April . . .	255	30	3,090,150	103,000	153.2	20,175	20.2	135.66
May	320	00	4,001,700	129,100	165.4	24,200	20.9	136.82
June . . .	364	30	4,700,925	156,700	170.3	27,600	18.6	136.95
July	424	00	5,377,875	173,500	166.2	32,350	19.4	137.70
August . .	321	30	4,022,175	129,700	172.8	23,275	16.5	137.53
September .	315	00	3,865,500	128,900	176.5	21,900	16.0	136.42
October . .	292	00	3,183,450	102,700	166.0	19,175	15.5	137.21
November .	285	30	3,059,550	102,000	153.4	19,950	17.5	137.01
December .	316	00	3,470,100	111,900	143.4	24,200	18.0	136.95
Totals and averages,	3,682	00	44,351,100	121,500	157.6	281,375	18.7	136.72

TABLE XI.

Table showing Work done at Mystic Sewage Pumping-Station during the Year 1884.

1884.	Pumping time.		Amount of sewage pumped and treated.	Sulphate al. used.	Coal used.	Daily average amount of sewage pumped and treated.
	Hrs.	*Min.*	*Gallons.*	*Lbs.*	*Lbs.*	*Gallons.*
January	471	35	9,585,000	24,060	29,150	342,300
February	474	05	10,291,000	24,785	29,500	367,500
March	548	15	12,091,000	29,440	33,200	390,000
April	497	50	10,759,000	22,475	29,800	371,000
May	433	35	8,389,000	21,600	25,650	322,700
June	511	25	9,610,000	25,060	17,300	320,300
July	490	55	8,778,000	23,150	25,950	292,600
August	527	15	9,255,000	23,855	29,500	298,500
September	472	40	8,154,000	18,225	28,800	281,200
October	508	25	9,263,000	20,975	29,900	319,400
November	496	25	9,693,000	21,390	29,300	334,200
December	498	35	11,040,000	19,350	29,700	368,000
Totals	5,931	00	116,908,000	274,365	337,750	334,000

TABLE XII.

Rainfall in Inches and Hundredths on Sudbury River Water-shed for the Year 1894.

1894.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	0.025	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	0.515
3	...	...	...	...	...	0.420	0.210	0.700	...	...	0.605	...
4	...	0.295	...	0.375	0.110	...	0.290	0.045	...	...	...	...
5	0.045	...	...	...	...	0.005	...	...	...	0.460	...	...
6	0.085	...	...	...	0.290	...	...	...	0.190	...	1.260	...
7	...	...	...	...	0.005	...	...	...	...	...	...	...
8	...	...	...	...	...	...	...	...	0.200	...	0.375	...
9	...	...	0.010	0.890	...	...	...	0.145	...	0.080	...	...
10	...	0.730	...	...	...	...	...	...	...	1.645	0.280	0.675
11	0.135	...	0.030	...	0.025	0.100	...	...	...	...	...	...
12	0.055	...	...	...	...	...	...	...	...	...	...	0.875
13	...	1.295	...	1.625	...	...	...	0.210	...	...	...	...
14	0.020	...	0.095	...	...	...	0.250	0.140	...	0.730	0.150	...
15	...	0.865	0.160	...	...	...	...	0.030	0.050	...	...	...
16	0.220	...	...	...	...	...	0.075	...	...	...	...	...
17	...	...	...	...	...	...	...	...	0.350	...	...	...
18	...	0.310	...	...	...	...	...	...	...	...	0.110	...
19	0.145	...	...	...	0.615	...	...	...	...	...	...	...
20	...	0.245	...	...	...	...	...	0.760	1.755	...	...	...
21	...	...	0.075	0.160	0.280	0.460	0.090	...	...	...	0.395	...
22	...	...	...	0.040	...	...	0.500	...	...	...	...	...
23	...	...	0.830	...	0.030	0.170	...	...	...	...	...	...
24	0.460	...	...	0.325	0.785	...	0.845	...	...	...	...	...
25	...	...	...	...	0.080	...	0.800	...	...	...	0.150	0.255
26	...	0.145	0.060	...	0.025	...	...	...	...	1.670	...	...
27	1.160	...	...	...	...	...	...	...	...	...	...	2.490
28	...	...	...	...	...	...	...	...	...	...	...	...
29	...	...	0.175	...	1.545	...	0.195	...	...	...	...	...
30	1.765	...	...	...	...	...	...	...	0.090	...	0.100	...
31	...	...	...	...	0.445	...	...	...	...	0.760	...	...
Totals .	4.090	3.910	1.435	3.415	4.235	1.155	3.255	2.030	2.635	5.345	3.425	4.810

Total rainfall during the year, 39.740 inches, being an average of two gauges, located at Framingham and Ashland.

TABLE XIII.

Rainfall in Inches and Hundredths at Lake Cochituate for the Year 1894.

1894.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	0.02	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	0.02	...	...	...	...	...	...	0.49
3	...	...	...	...	...	0.45	0.22	0.71	...	...	0.54	...
4	...	...	...	0.33	0.16	...	0.23	0.05	...	...	...	...
5	...	0.21	...	...	...	0.01	...	...	...	0.64	...	...
6	0.04	...	0.01	0.01	0.29	...	...	...	0.10	...	1.46	...
7	0.05	...	...	...	...	...	...	...	...	...	...	...
8	...	...	...	...	...	...	...	0.16	0.16	...	...	...
9	...	...	...	1.03	...	...	...	...	...	0.08	...	...
10	...	0 63	...	...	...	...	...	...	...	1.53	0.64	0.64
11	0.17	...	0.02	...	...	0.08	...	...	...	...	...	...
12	...	...	...	...	...	...	...	...	...	...	...	0.84
13	...	1.31	...	1.42	...	...	...	...	...	...	...	...
14	...	...	0.08	...	...	...	0.14	0.29	...	0.92	0.17	...
15	...	0.85	0.13	...	...	...	...	0.03	0.06	...	...	...
16	0.24	...	...	...	...	...	0.14	...	...	...	...	...
17	...	...	...	...	...	0.26	...	...	0.26	...	0.10	...
18	...	0.34	...	...	...	...	...	...	...	...	0.02	...
19	0.14	...	...	...	...	...	...	0.04	...	...	...	...
20	...	0.22	...	...	...	...	...	1.29	1.62	...	...	...
21	...	...	0.03	...	0.86	0.79	...	...	...	...	0.33	...
22	...	...	...	0.22	...	...	0.86	...	...	...	...	...
23	...	...	0.65	...	...	0.02	...	...	...	...	0.01	...
24	...	...	...	0.26	0.66	...	0.57	...	...	...	...	...
25	0.42	...	...	...	0.08	...	1.24	...	...	...	0.16	0.23
26	...	0.31	...	...	...	...	...	...	...	1.37	...	...
27	1.27	...	...	...	...	...	...	...	...	...	...	2.18
28	...	...	...	...	...	...	...	...	...	...	...	...
29	...	...	0.24	...	1.13	...	0.21	...	..	...	...	...
30	1.62	...	...	...	...	...	...	...	0.07	...	0.10	...
31	...	...	...	...	0.50	. .	...	...	...	0.60	...	...
Totals.	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2.27	5.14	3.53	4.38

Total rainfall during the year, 39.08 inches.

TABLE XIV.

Rainfall in Inches and Hundredths at Mystic Lake for the Year 1894.

1894.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	...	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	...
3	...	...	...	...	...	0.16	0.38	0.44	...	...	0.77	0.44
4	...	...	...	0.39	...	0.02	...	0.06	...	...	...	...
5	...	0.21	...	...	0.24	...	...	...	...	0.52	...	...
6	0.10	...	...	...	0.32	...	...	...	0.06	...	1.59	...
7	0.07	...	...	...	...	0.20	...	...	...	...	...	...
8	...	0 03	...	...	...	...	...	...	0.34	...	...	...
9	...	...	...	1.03	...	...	...	0.29	...	0.16	...	...
10	...	0.78	0.03	...	...	...	...	0.86	0.02	1.70	0.35	0.47
11	...	...	0.01	...	...	...	...	...	...	...	...	...
12	0.21	...	...	...	...	...	...	...	...	...	...	0.81
13	...	0.95	...	...	...	...	...	0.17	...	...	...	...
14	...	...	0.10	1.73	...	...	0.01	0.02	...	1.36	0.18	...
15	..	0.86	...	...	...	...	...	...	0.08	...	...	...
16	0.32	...	0.06	...	...	...	...	...	...	...	...	...
17	...	...	...	...	...	...	...	...	0.44	...	0.16	...
18	...	0.29	...	...	...	...	...	...	...	...	...	...
19	0.23	...	...	...	1.33	...	...	...	...	...	0.02	...
20	...	0.19	...	...	...	...	...	0.68	1.58	...	...	...
21	...	...	0.02	...	0.34	0.34	0.67	...	...	...	0.23	...
22	...	...	...	0.12	...	...	0.80	...	...	...	...	...
23	...	...	0.63	...	0.05	...	...	...	...	...	...	...
24	...	...	...	0.18	...	...	0.81	...	...	...	...	...
25	0.40	...	...	...	0.94	...	0.69	...	...	...	0.09	0.25
26	...	...	0.06	...	0.04	...	...	...	...	1.30	...	...
27	1.20	...	...	...	...	...	...	...	...	0.02	...	2.00
28	...	...	...	0.03	...	...	...	...	...	...	...	...
29	...	...	0.18	...	1.30	...	...	...	...	...	...	...
30	1.40	...	...	...	...	...	0.09	...	...	...	0.10	...
31	...	...	...	...	0.62	...	...	...	...	0.52	...	...
Totals.	3.93	3.21	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97

TABLE XV.

Monthly Rainfall in Inches, during 1894, at Various Places in Eastern Massachusetts.

Place.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Framingham	4.23	3.91	1.41	3.28	4.37	1.11	3.82	1.94	2.78	5.20	3.43	4.81	40.29
Dam 4, Ashland	3.95	3.91	1.46	3.55	4.10	1.20	2.69	2.12	2.49	5.49	3.42	4.81	39.19
Cordaville	3.75	3.98	1.49	3.86	4.78	2.14	3.14	2.75	2.49	5.76	3.58	4.55	42.27
Lake Cochituate	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2.27	5.14	3.53	4.38	39.08
Chestnut Hill	3.90	3.81	1.14	3.24	4.27	0.20	3.33	2.27	2.50	6.04	3.41	4.06	38.17
Mystic Lake	3.93	3.31	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97	39.24
Winchester	3.43	3.04	0.96	2.60	4.24	0.31	3.14	1.24	1.97	4.93	3.64	4.18	33.68
Mystic Pumping-station	3.79	3.09	0.99	2.64	4.74	0.52	3.13	1.75	3.04	5.38	3.46	4.46	36.99
Boston Pipe-yard	3.84	3.28	1.42	2.78	3.74	0.79	3.01	2.95	1.55	5.63	3.31	4.62	36.92
Cambridge Observatory	3.33	3.59	0.37	2.67	2.27	0.38	2.56	1.83	2.42	5.23	3.49	4.32	32.46
Waltham, Boston Manufacturing Co.	2.54	2.65	1.20	3.29	4.57	0.51	3.16	1.48	2.29	5.92	3.83	4.30	35.74
Lowell, Locks and Canals Co.	3.35	3.50	1.27	3.76	4.36	0.37	3.00	0.92	3.03	3.46	3.52	3.84	34.38
Average of twelve places	3.666	3.497	1.163	3.202	4.193	0.822	3.170	2.028	2.446	5.313	3.509	4.358	37.367

TABLE XVI.

Table showing the Temperature of Air and Water at Various Stations on the Water-Works.

1894.	Temperature of Air.						Temperature of Water.	
	Chestnut Hill Reservoir.			Framingham.			Brookline Reservoir.	Mystic Engine-House.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Mean.	Mean.
January	56.5	0.0	28.9	54.0	-6.0	26.7	37.2	36.2
February	52.5	-10.0	25.9	49.0	-14.0	24.2	36.9	35.8
March	70.5	17.0	41.8	69.0	15.0	40.6	40.8	38.0
April	80.5	18.0	47.5	79.0	16.0	45.8	45.6	43.7
May	89.0	34.5	59.3	88.0	30.0	57.7	59.7	58.9
June	97.0	41.5	69.7	95.0	40.0	69.3	66.5	66.9
July	105.5	50.0	75.9	98.0	47.0	74.2	74.5	75.9
August	92.5	42.0	69.1	90.0	40.0	67.2	73.2	72.4
September	90.0	40.0	65.2	90.0	31.0	63.8	68.2	67.2
October	76.5	32.5	52.8	76.0	28.0	51.3	57.2	53.8
November	65.0	11.0	36.6	64.0	8.0	35.2	43.8	41.5
December	55.0	5.0	30.4	52.0	0.0	27.7	37.6	36.1

TABLE XVII.

Rainfall in Inches on Cochituate Water-shed, 1863 to 1894.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months, July-Oct.
1863	4.10	4.38	3.57	11.34	2.66	1.98	14.12	5.61	3.39	4.56	8.54	5.05	69.30	27.68
1864	3.37	0.98	8.44	4.02	2.84	0.58	1.06	3.56	1.52	6.50	5.45	4.28	42.60	12.64
1865	4.99	4.45	5.48	2.18	8.25	0.91	3.10	3.36	1.66	6.99	4.78	3.31	49.46	15.11
1866	1.44	5.80	3.92	1.94	6.46	4.80	13.35	3.98	8 36	3.43	4.52	4.32	62.32	29.12
1867	2.76	5.40	5.65	2.43	6.46	2.95	5.36	12.36	1.08	7.27	2.63	1.90	56.25	26.07
1868	3.70	1.18	2.51	5.61	8.12	2.95	2.16	7.38	7.69	1.19	6.77	0.45	49.71	18.42
1869	3.71	7.07	7.52	2 57	7.59	3.68	2.63	2.34	8.49	9.50	3.26	5.98	64.34	22.96
1870	7.85	4.68	6.04	8.81	3.14	4.05	3.10	2.03	0.64	7.96	4.40	3.19	55.89	13.73
1871	1.31	2.30	5.02	2.29	5.66	5.96	2.20	3.56	1.46	5.38	7.01	3.24	45.39	12.60
1872	1.86	1.37	3.06	1.74	3.24	4.27	5.55	9.76	6.29	3.69	4.22	3.42	48.47	25.29
1873	4.24	2.43	3.98	2.69	3.24	0.38	4.08	7.17	2 62	6.11	4.54	3.95	45.43	19.98
1874	2.96	2.90	1.19	6.36	3.40	4.79	3.16	4.83	1.55	1.04	2.05	1.70	35.93	10.58
1875	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49	17.38
1876	1.83	4.21	7.43	3.24	2.80	1.60	9.49	2.19	3.98	2.00	6.59	3.13	48.49	17.66
1877	3.19	0.53	7.79	3.24	3.73	2.64	2.77	3.35	0.46	8.14	6.94	1.02	43.80	14.72
1878	5.77	5.93	4.20	5.63	0.83	3.33	3.47	6.94	1.12	5.15	6.09	5.12	53.58	16.68
1879	2.00	3.05	3.90	4.69	1.20	4,14	3.38	6.43	1.74	0.90	2.98	3.60	38.01	12.45
1880	3.07	4.05	2.83	2.94	1.98	1.25	7.00	3.81	1.69	2.95	1.70	2.56	35.83	15.45

1881	5.56	4.43	4.79	1.71	3.18	4.83	2.78	1.13	2.13	2.87	3.85	3.83	41.09	8.91
1882	5.93	3.96	2.76	1.89	4.73	1.87	3.49	1.14	9.20	2.22	0.93	2.17	40.29	16.05
1883	2.88	3.59	1.76	2.27	3.95	1.81	2.88	0.39	1.31	5.16	2.06	3.14	31.20	9.74
1884	4.39	6.04	4.50	3.80	2.92	3.88	4.42	4.49	0.90	2.59	2.33	5.31	45.57	12.40
1885	5.25	3.98	1.09	3.71	3.46	2.96	1.73	7.01	1.63	5.26	5.26	2.32	43.66	15.63
1886	6.53	6.86	3.46	2.00	2.97	1.21	3.30	3.75	3.20	3.16	4.76	5.77	46.97	13.41
1887	5.29	5.34	5.10	4.45	1.92	2.58	3.77	3.70	1.28	2.49	2.76	3.80	41.58	11.24
1888	4.13	3.55	5.60	2.51	4.63	2.07	1.67	6.32	8.81	4.95	7.03	5.66	56.93	21.75
1889	5.46	1.56	2.28	3.19	3.64	3.17	9.10	4.57	4.92	3.85	5.79	2.70	50.23	22.44
1890	2.34	3.21	7.35	2.51	5.31	1.78	2.31	3.34	6.47	10.11	1.24	5.26	51.23	22.23
1891	6.67	5.02	5.49	3.62	1.67	3.78	2.99	4.91	2.12	4.14	2.84	3.17	46.42	14.16
1892	4.78	2.80	4.12	0.78	5.46	3.23	3.47	3.79	2.87	1.42	5.14	1.18	39.04	11.55
1893	2.61	7.26	3.13	3.21	5.45	2.75	2.40	5.86	1.76	3.74	2.08	5.03	45.28	13.76
1894	3.95	3.89	1.16	3.27	3.70	1.61	3.61	2.57	2.27	5.14	3.53	4.38	39.08	13.59
Totals.	126.34	125.35	138.86	113.87	127.25	94.03	137.47	147.16	106.04	144.71	136.90	110.88	1508.86	535.38
Averages.	3.95	3.92	4.34	3.56	3.97	2.94	4.30	4.60	3.31	4.52	4.28	3.46	47.15	16.73

TABLE XVIII.

Rainfall Collected, in Inches, on Cochituate Water-shed, 1863 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.	4 months, July-Oct.
1863	1.93	3.11	3.71	4.42	1.44	0.67	2.97	1.51	0.98	1.32	2.65	2.17	26.88	6.78
1864	2.39	1.56	4.05	2.65	1.62	0.49	0.41	0.68	0.49	1.43	1.25	1.33	18.35	3.01
1865	2.15	1.74	4.66	2.70	4.70	0.34	0.46	0.47	0.45	0.70	1.00	1.13	20.50	2.08
1866	0.73	2.84	1.76	1.63	1.29	1.10	1.20	0.64	1.34	0.93	0.99	1.56	16.01	4.11
1867	1.10	5.24	3.50	2.87	2.20	0.65	0.59	2.10	0.31	1.02	1.10	1.12	21.80	4.02
1868	1.22	1.12	3.84	3.48	6.17	1.59	0.45	1.18	1.85	0.95	1.96	1.17	24.98	4.43
1869	1.82	1.84	3.31	2.49	2.20	1.07	0.74	0.58	1.10	2.37	1.30	3.17	21.99	4.79
1870	4.71	3.93	3.38	6.87	1.66	0.97	0.53	0.41	0.86	1.11	0.88	0.77	26.08	2.91
1871	1.03	2.28	2.53	1.58	2.00	0.87	0.43	0.85	0.39	0.69	1.30	1.21	15.16	2.36
1872	1.15	0.93	1.41	3.08	1.10	1.49	0.14	1.32	1.70	1.69	2.00	1.21	17.22	4.85
1873	3.09	1.57	3.89	6.09	2.66	0.45	0.62	1.40	0.78	2.04	1.86	2.68	27.13	4.84
1874	3.55	2.19	1.84	3.19	2.78	1.96	0.95	0.92	0.53	0.52	0.58	0.51	19.52	2.92
1875	0.13	2.92	2.66	3.15	1.39	1.48	0.25	0.62	0.60	1.19	1.96	1.22	17.57	2.66
1876	1.09	1.78	5.19	4.20	1.43	0.51	0.84	0.29	0.88	0.49	1.85	0.99	19.54	2.50
1877	1.20	1.37	6.81	3.24	2.04	0.92	0.65	0.67	0.46	1.16	2.69	1.96	23.17	2.94
1878	3.25	3.97	5.40	2.86	1.66	0.76	0.47	0.84	0.29	0.73	2.07	4.04	26.34	2.33
1879	1.29	2.32	3.30	4.48	1.40	0.77	0.33	0.95	0.61	0.60	0.72	1.04	17.81	2.49
1880	1.47	2.24	1.79	1.57	0.44	0.06	0.33	0.23	0.24	0.49	0.83	0.61	10.30	1.29
1881	1.19	2.23	5.66	1.79	1.26	1.31	0.16	0.09	0.23	0.18	0.84	1.40	16.34	0.66
1882	1.84	3.00	3.67	0.93	1.55	0.62	0.06	0.07	0.97	0.84	0.58	0.92	15.05	1.94
1883	0.84	1.59	2.04	1.66	1.26	0.07	0.02	0.07	0.62	0.59	0.41	0.94	10.11	1.30
Am'ts forward	37.17	49.77	74.40	64.93	42.25	18.15	12.60	15.89	15.68	21.04	28.82	31.15	411.85	65.21

Rainfall Collected, in Inches, on Cochituate Water-shed, 1863 to 1894, Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.	4 months, July-Oct.
Am'ts forward	37.17	49.77	74.40	64.93	42.25	18.15	12.60	15.89	15.68	21.04	28.82	31.15	411.85	65.21
1884	1.84	2.86	4.67	4.00	1.39	0.67	0.26	0.61	0.13	0.34	0.62	1.82	19.21	1.34
1885	1.90	2.00	2.21	2.36	1.61	0.43	0.00	0.33	0.25	0.79	2.05	1.64	15.57	1.37
1886	2.28	7.93	3.51	2.52	1.09	0.18	0.25	0.14	0.30	0.42	1.20	2.10	21.92	1.11
1887	4.06	4.34	4.70	3.36	1.35	0.82	0.72	1.33	0.64	0.49	0.70	0.96	23.47	3.18
1888	1.13	2.77	4.76	3.45	2.37	0.53	0.47	0.94	2.31	2.57	4.21	5.46	30.97	6.29
1889	4.50	1.85	2.08	2.17	1.20	1.18	1.63	3.43	1.79	1.91	2.95	3.26	27.95	8.76
1890	1.92	2.04	5.87	2.23	1.85	1.41	0.33	0.46	1.40	3.40	1.49	2.11	24.51	5.59
1891	6.26	6.62	8.03	4.31	0.88	0.77	0.50	0.72	0.76	0.79	0.83	1.60	32.07	2.77
1892	3.18	1.64	3.12	0.90	2.03	0.49	0.33	0.56	0.60	0.57	1.09	0.84	15.35	2.06
1893	0.64	2.55	4.12	2.42	1.83	0.75	0.38	0.77	0.42	1.09	1.00	1.68	17.65	2.66
1894	1.27	1.69	2.55	2.15	0.91	0.45	0.38	0.41	0.46	0.66	0.92	1.14	12.99	1.91
Totals . . .	66.15	86.06	120.02	94.80	58.76	25.83	17.85	25.59	24.74	34.07	45.88	53.76	653.51	102.25
Averages .	2.07	2.69	3.75	2.96	1.84	0.81	0.56	0.80	0.77	1.06	1.43	1.68	20.42	3.19

TABLE XIX.

Percentage of Rainfall Collected on Cochituate Water-shed, 1863 to 1894.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly.	4 months, July-Oct.
1863	47.0	71.0	104.0	39.0	54.0	34.0	21.0	27.0	29.0	29.0	31.0	43.0	38.8	24.5
1864	71.0	159.0	48.0	66.0	57.0	84.0	39.0	19.0	32.0	22.0	23.0	31.0	43.0	23.8
1865	43.0	39.0	85.0	124.0	57.0	37.0	15.0	14.0	27.0	10.0	21.0	34.0	41.4	13.8
1866	51.0	49.0	45.0	84.0	20.0	23.0	9.0	16.0	16.0	27.0	22.0	36.0	25.7	14.1
1867	40.0	97.0	62.0	118.0	34.0	22.0	11.0	17.0	29.0	14.0	42.0	59.0	38.7	15.4
1868	33.0	95.0	153.0	62.0	76.0	54.0	21.0	16.0	24.0	80.0	29.0	261.0	50.2	24.0
1869	49.0	26.0	44.0	97.0	29.0	29.0	28.0	25.0	13.0	25.0	40.0	53.0	34.2	20.9
1870	60.0	84.0	56.0	78.0	53.0	24.0	17.0	20.0	134.0	14.0	20.0	24.0	46.7	21.2
1871	79.0	99.0	50.4	68.8	35.3	14.6	19.6	23.8	26.8	12.8	18.5	37.4	33.4	18.7
1872	61.8	67.8	46.0	177.3	33.8	34.8	2.6	13.5	27.0	45.7	47.4	35.3	35.5	19.2
1873	72.9	64.8	97.8	226.4	82.2	119.1	15.1	19.5	29.8	33.4	40.9	67.9	59.8	24.2
1874	120.0	75.5	154.7	50.2	81.7	40.8	30.0	19.1	34.3	50.3	28.4	29.9	54.3	27.6
1875	5.5	92.8	71.2	97.5	39.9	23.7	7.1	11.2	17.4	24.6	40.5	129.8	38.6	15.3
1876	59.3	42.4	69.9	129.7	50.9	31.6	8.9	13.3	22.2	24.3	28.1	31.5	40.3	14.2
1877	37.6	258.9	87.4	100.0	54.6	34.8	23.3	19.6	99.8	14.3	38.8	192.6	52.9	20.0
1878	56.3	66.9	128.6	50.7	200.0	23.2	13.5	12.0	25.8	14.3	34.0	78.8	49.2	14.0
1879	64.4	76.3	84.5	95.6	117.0	18.6	9.7	14.7	35.0	66.5	24.2	28.9	46.9	20.0
1880	47.9	55.3	63.3	53.3	22.2	4.5	4.7	6.1	14.3	16.6	48.9	23.8	28.7	8.3

1881	21.5	50.3	118.1	104.8	39.6	27.0	5.8	7.6	10.8	6.4	21.8	36.7	39.8	7.4
1882	31.0	75.9	133.9	49.3	32.8	33.1	1.7	6.2	10.5	37.9	62.4	42.3	37.4	12.1
1883	29.2	44.3	115.8	73.1	31.9	3.7	0.6	18.6	47.4	11.5	20.0	29.8	32.4	13.3
1884	41.8	47.4	103.9	105.1	47.5	17.3	5.0	13.6	14.9	13.1	26.7	34.2	42.2	10.8
1885	36.1	50.2	202.7	63.6	46.7	14.4	0.0	4.8	15.5	15.0	39.0	70.7	35.7	8.8
1886	36.6	107.3	101.9	154.3	43.0	35.5	11.1	7.8	10.7	13.4	21.7	29.7	49.7	8.3
1887	60.2	80.8	72.0	81.3	112.0	47.3	13.2	27.1	32.0	18.7	23.4	25.6	47.8	28.3
1888	27.5	78.0	85.0	137.3	51.2	25.8	28.1	14.9	26.2	51.9	59.9	96.4	54.4	28.9
1889	82.5	118.7	91.5	68.1	32.9	37.1	17.9	75.0	36.4	49.6	50.9	120.9	55.6	39.0
1890	82.0	63.4	79.9	88.9	34.9	79.1	14.2	13.9	21.6	33.7	120.0	40.2	47.9	25.1
1891	93.8	131.9	146.3	119.1	52.8	20.4	16.7	14.7	35.9	19.0	29.2	50.5	69.1	19.6
1892	66.6	58.5	75.7	115.5	37.1	15.3	9.5	14.7	21.1	40.2	21.2	71.1	39.3	17.8
1893	24.5	35.1	131.7	75.7	33.5	27.2	15.9	13.2	23.9	28.8	48.4	33.4	39.0	19.3
1894	32.3	43.5	219.7	65.8	24.6	27.9	10.4	16.1	20.0	12.8	26.1	26.1	33.3	14.1
Totals	1664.3	2505.0	3128.0	3019.4	1718.1	1063.8	446.5	555.0	963.3	875.8	1148.4	1904.5	1381.9	592.0
Average	52.0	78.3	97.8	94.4	53.7	33.2	14.0	17.3	30.1	27.4	35.9	59.5	43.2	18.5

TABLE XX.

Rainfall, in Inches, on Sudbury River Water-shed, 1875 to 1894.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months. July-Oct.
1875	2.420	3.150	3.740	3.230	3.560	6.240	3.570	5.530	3.430	4.850	4.830	0.940	45.490	17.380
1876	1.830	4.210	7.430	4.197	2.763	2.040	9.134	1.720	4.614	2.241	5.764	3.620	49.563	17.709
1877	3.216	0.739	8.357	3.435	3.702	2.425	2.951	3.682	0.323	8.515	5.803	0.870	44.018	15.471
1878	5.632	5.973	4.689	5.790	0.956	3.884	2.971	6.937	1.291	6.417	7.024	6.367	57.931	17.616
1879	2.478	3.562	5.140	4.716	1.579	3.789	3.933	6.509	1.878	0.809	2.682	4.344	41.419	13.129
1880	3.566	3.980	3.315	3.105	1.836	2.138	6.273	4.008	1.603	3.740	1.785	2.828	38.177	15.624
1881	5.558	4.646	5.730	2.000	3.511	5.395	2.350	1.358	2.617	2.955	4.091	3.958	44.169	9.280
1882	5.951	4.546	2.649	1.824	5.066	1.664	1.769	1.667	8.741	2.074	1.147	2.296	39.394	14.251
1883	2.810	3.865	1.780	1.845	4.185	2.400	2.680	0.735	1.520	5.600	1.810	3.550	32.780	10.535
1884	5.085	6.545	4.720	4.405	3.470	3.445	3.665	4.650	0.855	2.480	2.645	5.170	47.135	11.650
1885	4.710	3.865	1.070	3.605	3.485	2.865	1.425	7.185	1.425	5.095	6.095	2.720	43.545	15.130
1886	6.365	6.280	3.610	2.225	2.995	1.465	3.265	4.100	2.905	3.235	4.645	4.975	46.065	13.505
1887	5.200	4.780	4.900	4.265	1.165	2.650	3.760	5.280	1.320	2.835	2.670	3.880	42.705	13.195
1888	4.150	3.685	6.020	2.425	4.825	2.535	1.405	6.225	8.585	4.990	7.225	5.395	57.465	21.205
1889	5.370	1.655	2.365	3.410	2.945	2.800	8.940	4.175	4.605	4.255	6.290	3.140	49.950	21.975
1890	2.530	3.505	7.735	2.645	5.210	2.030	2.460	3.865	6.000	10.510	1.200	5.310	53.000	22.835
1891	7.020	5.235	6.475	3.905	2.010	3.770	3.395	4.725	2.380	3.830	3.090	3.685	49.520	14.330
1892	5.850	3.140	4.060	0.830	5.585	2.760	4.230	4.440	2.840	1.170	5.800	1.125	41.830	12.680
1893	2.925	8.195	3.670	3.605	6.610	2.380	2.570	5.415	1.735	4.065	2.195	4.860	48.225	13.785
1894	4.090	3 910	1.435	3.415	4.235	1.155	3.255	2.030	2.635	5.345	3.425	4.810	39.740	13.265
Totals	86.756	85.466	88.890	64.877	69.693	57.830	74.001	84.236	61.302	85.011	80.216	73.843	912.121	304.550
Averages . . .	4.338	4.273	4.445	3.244	3.485	2.891	3.700	4.212	3.065	4.250	4.011	3.692	45.606	15.227

TABLE XXI.

Rainfall Collected, in Inches, on Sudbury River Water-shed, 1875 to 1894.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months, July-Oct.
1875	0.184	2.411	2.862	5.263	2.119	1.501	0.573	0.706	0.358	1.152	2.248	1.041	20.418	2.789
1876	1.147	2.282	7.911	5.683	2.031	0.383	0.326	0.723	0.318	0.417	1.878	0.809	23.908	1.784
1877	1.174	1.529	8.586	4.132	2.482	1.031	0.360	0.216	0.103	1.127	2.447	2.300	25.487	1.806
1878	3.228	3.972	6.256	2.807	2.487	0.873	0.229	0.848	0.277	0.921	2.922	5.667	30.487	2.275
1879	1.249	2.756	4.156	5.379	1.987	0.713	0.281	0.705	0.243	0.126	0.355	0.825	18.775	1.355
1880	2.000	2.982	2.451	2.017	0.917	0.303	0.315	0.212	0.138	0.181	0.354	0.312	12.182	0.846
1881	0.740	2.491	7.142	2.669	1.721	2.309	0.493	0.264	0.340	0.331	0.682	1.383	20.565	1.428
1882	2.213	3.872	5.064	1.497	2.304	0.913	0.154	0.099	0.529	0.534	0.362	0.561	18.102	1.316
1883	0.597	1.664	2.873	2.330	1.673	0.518	0.206	0.140	0.157	0.331	0.354	0.345	11.188	0.834
1884	1.775	4.742	6.752	4.925	1.838	0.719	0.399	0.458	0.076	0.148	0.302	1.650	23.784	1.081
1885	2.203	2.182	2.805	3.133	2.383	0.735	0.111	0.429	0.209	0.599	2.033	2.094	18.916	1.348
1886	2.606	7.734	3.672	3.361	1.285	0.350	0.206	0.168	0.203	0.260	1 161	1.819	22.825	0.837
1887	4.619	4.558	5.116	4.522	1.799	0.714	0.204	0.382	0.191	0.339	0.636	1.147	24.227	1.116
1888	1.878	3.255	5.775	4.566	2.912	0.728	0.209	0.677	1.994	3.563	4.761	5.428	35.749	6.446
1889	4.963	1.926	2.388	2.434	1.569	1.128	1.130	2.554	1.422	2.194	3.351	3.997	29.056	7.300
1890	2.237	2.463	6.498	3.236	2 437	0.980	0.191	0.235	0.790	4.053	2.097	1.776	26.993	5.269
1891	5.383	5.616	7.944	4.138	1.039	0.714	0.266	0.290	0.350	0.375	0.526	0.971	27.612	1.281
1892	3.335	1.574	3.488	1.504	2.245	0.739	0.382	0.500	0.396	0.224	1.204	0.865	16.456	1.502
1893	0.773	2.485	5.789	3.668	5.143	0.759	0.282	0.322	0.187	0.395	0.550	1.421	21.774	1.186
1894	1.236	1.596	3.992	2.832	1.498	0.723	0.287	0.373	0.258	0.668	1.442	1.277	16.182	1.586
Totals	43.540	62.090	101.520	70.096	41.869	16.833	6.604	10.301	8.539	17.941	29.665	35.688	444.686	43.385
Averages . . .	2.177	3.105	5.076	3.505	2.093	0.842	0.330	0.515	0.427	0.897	1.483	1.784	22.234	2.169

TABLE XXII.

Percentage of Rainfall Collected on Sudbury River Water-shed, 1875 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly.	4 months, July-Oct.
1875	7.6	76.5	76.5	162.9	59.5	24.0	16.0	12.8	10.4	23.8	46.5	110.7	44.9	16.0
1876	62.7	54.2	106.5	135.4	73.5	18.8	3.6	42.0	6.9	18.6	32.6	22.3	48.2	10.1
1877	36.5	206.9	102.7	120.3	67.0	42.5	12.2	5.9	31.9	13.2	42.2	264.4	57.9	11.7
1878	57.3	66.5	133.4	48.5	260.2	22.5	7 7	12.2	21.5	14.3	41.6	89.0	52.6	12.9
1879	50.4	77.4	80.9	114.1	125.8	18.8	7.1	10.8	12.9	15.6	13.2	19.0	45.3	10.3
1880	56.0	74.9	73.9	65.0	50.0	14.2	5.0	5.3	8.6	4.8	19.9	11.0	31.9	5.4
1881	13.3	53.6	124.6	133.4	49.0	42.8	21.0	19.4	13.0	11.2	16.7	34.9	46.6	15.4
1882	37.2	85.2	191.2	82.1	45.5	54.9	8.7	5.5	6.0	25.7	31.5	24.5	45.9	9.2
1883	21.2	43.0	161.4	126.3	40.0	21.6	7.7	19.1	10.4	5.9	19.5	9.7	34.1	7.9
1884	34.9	72.5	143.1	111.8	53.0	20.9	10.9	9.8	8.9	6.0	11.4	31.9	50.5	9.3
1885	46.8	56.4	262.1	86.9	68.4	25.7	7.8	6.0	14.7	11.8	33.3	77.0	43.4	8.9
1886	40.9	123.2	101.7	151.1	42.9	23.9	6.3	4.1	7.0	8.0	25.0	36.6	49.5	6.2
1887	88.8	95.3	104.4	106.0	154.5	26.9	5.5	7.2	14.5	12.0	23.8	29.6	56.7	8.5
1888	45.3	88.3	95.9	188.3	60.3	28.7	14.9	10.9	23.2	71.4	65.9	100.6	62.2	30.4
1889	92.4	116.4	100.9	71.4	53.3	40.3	12.6	61.2	30.9	51.6	53.3	127.3	58.2	33.2
1890	88.4	70.3	84.0	122.3	46.8	48.2	7.8	6.1	13.2	38.6	174.7	33.5	50.9	23.1
1891	76.7	107.3	122.7	106.0	51.7	18.9	7.8	6.1	14.7	9.8	17.0	26.3	55.8	8.9
1892	57.0	50.1	85.9	181.1	40.2	26.8	9 0	11.3	13.9	19.2	20.7	76.9	39.3	11.8
1893	26.4	30.3	157.7	101.7	77.8	31.9	11.0	5.9	10.8	9.7	25.1	29.2	45.2	8.6
1894	30.2	40.8	278.2	82.9	35.4	62.6	8.8	18.4	9.8	12.5	42.1	26.5	40.7	12.0
Totals . .	970.0	1589.1	2587.7	2297.5	1454.8	615.0	191.4	280.4	283.2	383.7	756.0	1180.9	959.8	259.8
Averages .	48.5	79.5	129.4	114.9	72.7	30.7	9.6	14.0	14.2	19.2	37.8	59.0	48.0	13.00

TABLE XXIII.

Rainfall, in Inches, on Mystic Water-shed, 1878 to 1894.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Totals.	4 months, July-Oct.
1878	5.67	5.74	3.93	5.73	0.67	2.62	3.52	7.51	3.19	4.95	5.69	4.845	54.065	19.17
1879	1.82	2.73	3.52	4.65	1.86	3.98	2.39	5.48	1.60	0.77	2.76	3.74	35.30	10.24
1880	2.62	4.23	2.49	2.18	2.02	1.49	7.23	3.64	1.42	2.70	1.90	2.50	34.42	14.99
1881	5.82	3.63	6.69	1.54	2.98	6.84	2.60	0.67	2.17	2.16	3.52	3.29	41.91	7.60
1882	5.545	4.68	2.49	2.11	4.58	2.09	2.34	1.065	8.35	1.94	1.745	2.23	39.165	13.695
1883	2.67	3.065	2.22	2.47	3.585	1.635	2.785	0.87	1.495	5.45	1.98	2.995	31.22	10.60
1884	4.745	6.085	4.255	3.18	2.95	4.635	3.72	4.855	0.70	2.70	2.005	4.56	44.39	11.975
1885	4.83	3.40	1.175	3.445	3.945	4.41	2.04	5.90	1.425	5.52	6.31	2.10	44.50	14.885
1886	6.315	7.175	3.84	2.10	2.945	1.54	3.71	3.24	2.955	2.85	4.065	4.825	45.560	12.755
1887	5.245	4.47	5.00	4.605	1.69	2.695	6.585	4.965	1.50	3.04	3.05	3.575	46.42	16.090
1888	4.05	3.28	5.185	2.84	5.095	2.20	2.23	6.23	8.56	4.955	6.85	5.27	56.745	21.975
1889	5.505	1.86	2.285	3.61	4.64	3.315	8.455	3.92	4.705	3.59	5.65	2.86	50.395	20.67
1890	2.725	3.38	6.68	2.405	6.30	3.38	2.265	3.64	3.70	8.84	1.385	4.67	49.37	18.445
1891	6.245	5.075	6.07	3.15	2.46	4.43	3.18	3.88	2.16	4.735	2.605	3.41	47.40	13.955
1892	4.515	3.015	4.005	0.815	5.585	4.15	2.575	4.82	2.005	1.835	4.645	1.15	39.115	11.235
1893	2.26	7.50	2.55	3.37	6.26	2.10	2.04	5.41	2.01	4.10	2.25	4.35	44.20	13.56
1894	3.93	3.31	1.09	3.48	5.18	0.72	3.45	2.52	2.52	5.58	3.49	3.97	39.24	14.07
Totals	74.510	72.625	63.475	51.680	62.745	52.230	61.115	68.615	50.465	65.715	59.900	60.340	743.415	245.910
Averages . . .	4.383	4.272	3.734	3.040	3.691	3.072	3.595	4.036	2.969	3.865	3.524	3.549	43.730	14.465

TABLE XXIV.

Rainfall Collected, in Inches, on Mystic Water-shed, 1878 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.	4 months, July-Oct.
1878	3.55	3.97	4.91	2.21	2.16	0.78	0.48	1.11	0.56	0.71	1.75	3.63	25.82	2.86
1879	1.21	2.33	3.31	3.97	1.95	0.97	0.54	0.70	0.48	0.34	0.45	0.69	16.94	2.06
1880	1.70	2.54	1.95	1.50	0.96	0.51	0.67	0.54	0.45	0.36	0.44	0.59	12.21	2.02
1881	0.82	2.14	6.79	2.17	1.51	2.05	0.87	0.35	0.31	0.29	0.50	0.87	18.67	1.82
1882	1.37	3.03	4.19	1.16	1.85	0.81	0.35	0.22	0.53	0.58	0.39	0.57	15.05	1.68
1883	0.70	1.43	1.88	1.63	1.20	0.52	0.30	0.22	0.18	0.39	0.42	0.44	9.31	1.09
1884	1.49	3.89	5.42	3.85	1.48	0.85	0.58	0.60	0.23	0.27	0.35	1.17	20.18	1.68
1885	1.79	1.81	2.05	2.03	2.18	0.86	0.47	0.54	0.34	0.68	2.41	2.39	17.55	2.03
1886	2.31	7.70	3.91	3.24	1.27	0.55	0.41	0.25	0.32	0.38	0.88	1.43	22.65	1.36
1887	3.16	3.61	3.60	3.75	1.89	1.27	0.87	1.35	0.48	0.57	0.71	0.91	22.17	3.27
1888	1.43	3.32	4.28	3.27	2.88	0.84	0.39	0.54	1.31	2.74	5.04	5.08	31.12	4.98
1889	4.51	1.83	1.60	2.27	2.18	1.89	1.33	2.05	1.06	1.21	2.49	3.06	25.48	5.65
1890	2.07	2.23	5.37	2.93	3.00	1.92	0.43	0.46	0.58	2.61	1.95	2.49	26.04	4.08
1891	6.29	5.97	7.21	3.43	1.40	1.01	0.42	0.44	0.42	0.58	0.56	0.87	28.60	1.86
1892	2.49	1.76	3.03	1.33	2.10	1.17	0.66	0.49	0.56	0.45	1.07	0.87	15.98	2.16
1893	0.75	2.14	4.52	2.72	4.42	1.04	0.47	0.69	0.41	0.55	0.71	1.27	19.69	2.12
1894	1.37	1.87	3.05	2.27	1.31	0.91	0.49	0.38	0.36	0.58	0.91	0.90	14.40	1.81
Totals	37.01	51.57	67.07	43.73	33.74	17.95	9.73	10.93	8.58	13.29	21.03	27.23	341.86	42.53
Averages . . .	2.18	3.03	3.95	2.57	1.98	1.06	0.57	0.64	0.51	0.78	1.24	1.60	20.11	2.50

TABLE XXV.

Percentage of Rainfall Collected on Mystic Water-shed, 1878 to 1894.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly.	4 months, July–Oct.
1878	62.6	69.2	125.0	38.6	322.9	29.6	13.5	14.8	17.7	14.3	30.8	74.9	47.8	14.9
1879	66.6	85.4	93.9	85.3	104.9	24.5	22.6	12.8	29.7	44.2	16.2	18.6	48.0	20.1
1880	64.9	60.1	78.4	68.8	47.3	34.3	9.2	14.7	31.7	13.5	22.9	23.8	35.5	13.5
1881	14.2	58.9	101.5	141.1	50.7	29.9	33.3	51.9	14.1	13.6	14.3	26.3	44.5	23.9
1882	24.8	64.8	168.4	55.0	40.4	38.6	14.9	20.8	6.3	30.0	22.2	25.5	38.4	12.3
1883	26.1	46.7	84.8	65.9	33.5	31.8	10.8	25.7	12.1	7.2	21.1	14.7	29.8	10.3
1884	31.5	63.9	127.3	121.2	50.2	18.3	15.5	12.4	33.5	9.9	17.4	25.6	45.5	14.0
1885	37.1	53.3	174.5	58.8	55.3	19.6	22.8	9.2	23.7	12.2	38.2	113.6	39.4	13.6
1886	36.6	107.3	101.9	154.3	43.0	35.5	11.1	7.8	10.7	13.4	21.7	29.7	49.7	10.7
1887	60.2	80.8	72.0	81.3	112.0	47.3	13.2	27.1	32.0	18.7	23.4	25.6	47.8	20.3
1888	35.2	101.3	82.5	115.2	56.6	38.1	17.5	8.8	15.3	55.3	73.6	96.4	54.8	22.7
1889	81.8	98.2	70.2	63.0	46.9	57.0	15.8	52.2	22.5	33.7	44.1	107.9	50 6	27.3
1890	75.6	66.0	80.4	121.8	47.6	56.9	19.0	12.7	15.6	29.5	141.2	53.5	52.8	22.1
1891	100.7	117.6	118.7	109.0	57.0	22.8	13.3	11.3	19.3	12.1	21.7	25.6	60.3	13.3
1892	55.0	58.5	75.7	163.6	37.5	28.3	25.7	10.2	27.7	24.3	23.1	75.2	40.9	19.2
1893	33.3	28.6	177.3	80.7	70.6	49.5	23.2	12.6	20.5	13.4	31.5	29.1	44.5	15.6
1894	34.8	56.5	280.1	65.4	25.3	125.8	14.2	15.1	14.3	10.5	26.0	22.7	36.7	12.9
Totals . .	841.0	1217.1	2012.6	1589.0	1201.7	687.8	295.6	320.1	346.7	355.8	589.4	787.8	767.0	286.7
Averages .	49.5	71.6	118.4	93.5	70.7	40.5	17.4	18.8	20.4	20.9	34.7	46.3	45.1	16.9

TABLE XXVI.

Yield of Sudbury-River Water-shed, 1875-1894. Area of water-shed used, includes water surfaces.

YEAR.	Rain-fall.	Daily Average Yield for Year.	Yield per Square Mile per day.	Rain-fall, July-Oct.	Daily average Yield, July-Oct.	Yield per Square Mile per Day.	Minimum Monthly Yield.				Minimum Yield in any Week.		
								Rain-fall.	Daily average Yield for Month.	Yield per Square Mile per Day.		Daily average Yield for Week.	Yield per Square Mile per Day.
	Inches.	Gallons.	Gallons.	Inches.	Gallons.	Gallons.	Month.	Inches.	Gallons.	Gallons.	Week.	Gallons.	Gallons.
1875	45.490	75,599,200	972,200	17.380	30,650,400	394,100	January . . .	2.420	About 8,000,000	102,900			
1876	49.563	88,278,400	1,135,200	17.709	19,603,300	252,100	July	9.134	14,229,000	183,000		4,000,000	51,400
1877	44.018	94,369,200	1,213,500	15.471	19,832,100	255,000	September . .	0.323	4,633,300	59,600		1,800,000	23,100
1878	57.931	112,882,200	1,451,600	17.616	25,001,600	321,500	July	2.971	9,983,900	128,400		5,300,000	68,200
1879	41.419	69,942,200	894,000	13.129	14,974,000	191,400	October . . .	0 809	5,532,300	70,700			
1880	38.177	45,250,300	578,400	15.624	9,356,100	119,600	September . .	1.603	6,280,000	80,300			
1881	44.169	73,633,900	979,200	9.280	15,178,900	201,800	August . . .	1.358	11,135,500	148,100			
1882	39.394	64,812,300	861,900	14.251	13,977,200	185,900	August . . .	1.667	4,158,100	55,300	Aug. 20-26	2,604,000	34,600
1883	32.780	40,056,200	532,700	10.535	8,870,700	118,000	August . . .	0.735	5,906,500	78,500			
1884	47.135	84,929,200	1,129,400	11.650	11,487,000	152,800	September . .	0.855	3,303,300	43,900	Sept. 14-20	51,300	700
1885	43.545	67,721,600	900,600	15.130	14,313,000	190,300	July	1.425	4,667,700	62,100			
1886	46.065	81,730,700	1,086,800	13.505	8,891,900	118,200	August . . .	4.100	7,077,400	94,100			
1887	42.705	86,749,300	1,153,600	13.195	11,874,800	157,900	September . .	1.320	8,346,700	111,000	Sept. 18-24	6,162,900	82,000
1888	57.465	127,642,900	1,697,400	21.205	68,478,000	910,600	July	1.405	8,825,800	117,400			

1889	49.950	104,030,100	1,383,400	21.975	77,563,400	1,031,400	July	8.940	47,645,200	633,600			
1890	53.000	96,650,400	1,285,200	22.835	55,975,600	744,400	July	2.460	8,064,500	107,200	July 13–19	3,446,800	45,800
1891	49.520	98,865,500	1,314,700	14.330	13,608,900	181,000	July	3.395	11,212,900	149,100			
1892	41.830	58,753,000	781,300	12.680	15,957,700	212,200	October . . .	1.170	9,461,300	125,800			
1893	48.225	77,963,300	1,036,700	13.785	12,602,400	167,600	September . .	1.735	8,126,700	108,100			
1894	39.740	57,957,800	770,400	13.265	16,856,900	224,200	September . .	2.635	11,243,300	149,500			
Averages .	45.606	80,389,900	1,057,900	15.228	23,252,700	306,500							

SUMMARY OF STATISTICS.

REPORT FOR 1894.

Boston Water-Works, Suffolk County, Massachusetts, supplies also the cities of Somerville, Chelsea, and Everett.

Population by census of 1890:	
Boston	448,477
Chelsea	27,909
Somerville	40,152
Everett	11,068
Total	527,606
Date of construction:	
Cochituate Works	1848
Mystic "	1864

By whom owned. — City of Boston.

Sources of supply. — Lake Cochituate, Sudbury river, and Mystic lake.

Mode of supply. — Sixty-five per cent. from gravity works.
Thirty-five " " pumping "

PUMPING.

	COCHITUATE.	MYSTIC.
Builder of pumping machinery	Holly Mfg. Co., and Quintard Iron Works.	H. R. Worthington.
Description of coal used:		
a Kind	Bituminous.	Bituminous.
c Size	Broken.	Broken.
e Price per gross ton, in bins	$4.40, $4.52	$4.45, $3.85, $3.75, $5.25
f Per cent. of ash,	7.4	11.2

	COCHITUATE.	MYSTIC.
Coal consumed for year, in lbs.	4,637,660	8,763,800
Total pumpage for year, in gallons	3,795,830,595	3,751,418,700
Average dynamic head, in feet	126.18	148.62
Gallons pumped per lb. of coal	818.6	428.1
Duty in foot-lbs. per 100 lbs. of coal	86,459,300	53,057,500

	COCHITUATE.	MYSTIC.
Cost of pumping figured on pumping-station expenses, viz.:	$25,131.78	$32,924.65
Cost per million gallons raised to reservoir	$6.62	$8.777
Cost per million gallons raised one foot high	$0.052	$0.059

CONSUMPTION.

Estimated population	466,500	117,400
Estimated No. of consumers,	460,000	116,000
Total consumption, gallons,	16,994,405,800	3,752,970,500
Passed through meters	4,077,196,000	735,110,000
Percentage metered	24.0	19.6
Average daily consumption, gallons	46,560,000	10,282,100
Gallons per day, each inhabitant	99.8	87.6
Gallons per day, each consumer	101.2	88.6
Gallons per day to each tap,	679.2	442.1

DISTRIBUTION.

Mains.

	COCHITUATE.	MYSTIC.
Kind of pipe used,	Cast-Iron.	Cast-Iron, Wrought-Iron, and Cement.
Sizes	48 in. to 4 in.	30 in. to 3 in.
Extended, miles	12.75	6.9
Total now in use	572.80	173.7
Distribution-pipes less than 4 in., length, miles	1.7	4.7
Hydrants added	175	148
Hydrants now in use	6,217	1,446
Stop-gates added	193	156
Stop-gates now in use	6,359	2,138

Services.

Kind of pipe used,	Lead.	Lead and Wrought-Iron.
Sizes	$\frac{5}{8}$ in. to 6 in.	$\frac{1}{2}$ in. to 4 in.
Extended, feet	49,841	18,436
Service-taps added	1,970	859
Total now in use	68,556	23,257
Meters added	291	33
Meters now in use	4,337	494
Motors and elevators in use	540	21

C.

IMPROVED SEWERAGE.

The work of extending the Improved Sewerage System has been continued as fast as the limited appropriation would admit, and the following is a brief review of the work done during the past year:

The condition of the appropriation on February 1, 1895, was as follows:

Net appropriation	$6,375,404 96
Total expenditures	6,307,754 96
Unexpended balance February 1, 1895 .	$67,650 00

The following is a report of the work done:

DORCHESTER INTERCEPTING SEWER.

The Dorchester Intercepting Sewer is now about completed to Milton Lower Mills, a distance of 150 feet remaining to be built in Butler street. The work has been carried on by day labor with a force of experienced men, who have been steadily employed in this department since 1890. A force account, carefully kept during the past summer, shows that the work has been economically done.

During the year 3,950 linear feet of sewer was constructed, completing Sections 6, 7, and 8. At the crossing of Davenport brook special construction was necessary, owing to the high grade of the Intercepting Sewer, the bed of the brook and the water line of the sewer being about on the same level. The sewer was made of 42-inch iron pipe, and the brook carried under it by a siphon culvert with a total area of waterway (under the sewer) of 130 square feet. Substantial abutments of masonry were built, forming the side walls of the culvert and supporting the ends of the pipes, and a centre pier was constructed as an additional support for the pipes. Wooden bulkheads extend up and down stream from the abutments to confine the banks of the brook.

An overflow into Davenport brook with tide-gates was also built at this point. The common sewer in Granite avenue has been intercepted, and the sewage from a large area in Dorchester which formerly discharged into the Neponset river, causing a serious nuisance, now flows to Moon

island. The Granite-avenue common sewer was carried under the Intercepting Sewer by a siphon, and will be used as an overflow which is controlled by a regulator and tide-gates.

Section 9, Dorchester, extends from Granite avenue through marsh land along the northerly location line of the Old Colony Railway to Butler street, a distance of 3,600 feet. The sewer is of brick, egg-shaped, 3 feet × 4 feet, the grade being 1 in 2,000. In this section soft beds of mud were encountered, and piles were driven for a foundation to depths varying from 8 feet to 36 feet for 1,100 feet in length of the sewer. Care must be exercised if, at any future time, the low land is filled over or near the sections of sewer supported upon piles, and any unequal side pressure from the filling must be avoided.

Outfall Sewer.

The embankment, from the Squantum shore to the east shaft of Dorchester Bay tunnel, has been completed to grade 116; furnishing a roadway, thoroughly protected by ballast and riprap, from the shaft to the mainland.

D.

[FROM THE CITY ENGINEER'S REPORT TO THE BOARD OF PARK COMMISSIONERS.]

The Fens.

Drives and Walks. — The drive on the easterly side of the Tremont entrance and the walk near the water between Tremont entrance and Fen bridge have been surfaced, and the stone-crushing plant, which for several years has been located at this entrance, was removed and the machinery sold early in the season; also the several small buildings which were located here have been removed, and the grounds graded, loamed, and seeded to grass.

Electric Lighting. — The work of laying underground wires and erecting lamps, begun in 1893, was finished and the Fens lighted for the first time on April 27. As this was the first instance in this city where underground wires were laid for street or park lighting, a brief description of the work may be of interest.

Tar-coated wrought-iron pipes 1¼ inches in diameter were laid 18 inches below the surface. At points where there were abrupt changes of direction and at the foot of each lamp-post cast-iron boxes were placed, so that the cable can be removed and replaced or connections made without it being necessary to dig up the ground. Wherever there are loops in the line of the cable 2-inch pipes were laid in order that two cables could be drawn through them. When the pipes were laid, a small wire was drawn through them, to be used for drawing through the larger cable.

The cable is ⅝ inch in diameter, and is composed of a No. 4 B. & S. gauge copper wire, first covered with rubber and then with lead. This was drawn through the pipes and lamp-posts to the top of the lamp.

The lamp-posts are of the ordinary city pattern and are set in Portland-cement concrete. The supports for the hoods are of wrought-iron pipe branching from the cap of the posts in such a manner that the cable can be readily drawn up through them. The cable is not exposed at any point until the hanging board of the lamp is reached.

The lamps are 2,000-candle power arc lamps. The number on the Fens is 45, and the length of cable 18,893 feet. In addition to the arc lamps, 6 incandescent lamps of 32-

candle power have been placed under the Stony-brook bridge for lighting the walks.

The grounds are well lighted, but probably some additional lights will be required when the trees are fully grown.

John Boyle O'Reilly Statue. — A foundation has been built for this statue on the triangle of the junction of Boylston road and the Fenway, and a curb set around the site.

Covered Channels of Stony Brook and Muddy River.

These remain in the same condition they were a year ago. Some slight repairs have been made to the gates in the Muddy-river gate-chamber.

I wish to again call attention to the necessity of rebuilding the damaged portion of the Muddy-river conduit.

Riverway.

Grading. — Considerable grading has been done during the year, chiefly on the left bank of the stream, between it and the railroad and Audubon road, also around the Bridle-path bridge.

The work of filling Audubon road, under the contract with James Killian, dated December 5, 1893, has been finished, there having been deposited 36,844 cubic yards, at 49 cents per cubic yard.

Drives, Ride, and Walks. — The drive and ride were practically completed in 1893, with the exception of Audubon road, but owing to the lateness of the season some work remained to be done in the spring. Owing to the short time in which the filling was allowed to settle before the surfacing was done, the surface, in a few places, is now so much below grade that it will require reconstruction in the near future. The walks along the bank of the river have been surfaced.

Plantations. — All of these, except those near the Administration building, have been loamed, manured, and planted.

Bridges. — The sidewalk on Audubon bridge has been laid, the railing built, and the iron-work painted, thus completing this structure.

The Bridle-path bridge, built under a contract with Johnson Brothers, dated October 23, 1893, was finished on August 13, at a cost of $32,300. The working plans for this bridge were made from designs furnished by Messrs. Olmsted, Olmsted, & Eliot, and Shepley, Rutan, & Coolidge.

The bridge supports a bridle-path across the waterway and walks on either side of the latter. It is 28 feet wide to out-

side of parapets, with wing-walls at each corner flaring at angles of 66 degrees. The piers rest on a platform constructed of spruce piles capped with 10-inch × 10-inch spruce caps crosswise of the channel and covered with 4-inch spruce plank. The ends of the platform are protected by 1-inch sheet piling. The piers are 30 feet apart and extend along the channel sufficiently to support the banks and the walks; the total length of the piers with their wing-walls is 100 feet. The grade of the platform is 2.5 above city base, and the tops of the piers are at grade 15.5. The piers are of granite laid in courses, with a cut granite coping on top from which the arches spring.

The central arch is elliptical in form, with a span of 30 feet and a rise of 9 feet 6 inches. The side arches which span the walks are semicircles 15 feet in diameter. The width of the piers at the springing line is 4 feet 8 inches; the spandrels between the arches are pierced by semicircular openings of a diameter of 15 feet and springing from the same grade as the other arches. This longitudinal arch is also carried back 2 feet into each abutment to form recesses for seats. The openings through the spandrels are to afford passages to connect with the foot-bridge to be built across the channel, to connect the walks on either side. The abutments at the end of the bridge have concrete and pile foundations, the piles being cut off at grade 8 and having their tops imbedded in the concrete to a depth of one foot.

The face-work of the bridge above grade 15.5 is of seam-face granite, laid as three-headed work, with a belt course of red granite 8 inches thick, 2 feet 8 inches below the top of the parapet, and with red granite coping. The soffits of the arches, except the face voussoirs, are laid with 12-inch × 1½-inch speckled brick. All of the groins are laid with the same brick cut and ground to shapes. The remainder of the arch-work is of common brick, the thickness of the central arch being 24 inches and of the side arches 20 inches. The spandrels are filled solid with concrete, so that the top of the bridge is drained to the abutments. The whole of the top of the bridge was covered with cement, then washed with cement-wash, and then covered with tarred roofing-paper and tar.

Buildings. — A tool-house and shelter has been erected near Bernier street, under the direction of the architects, Messrs. Shepley, Rutan, & Coolidge. It is a circular building 24 feet in diameter; the basement and the piers supporting the roof are of seam-face granite. The basement is to be used as a tool-room, and contains bins for the storage of material for the repair of walks, etc. The building stands

on sloping ground so that the floor above the basement is on a level with the walk; this floor, which is intended for a shelter for visitors, is of asphalt, and is covered by a roof supported on stone piers; the roof is covered with tiles, and seats are provided.

Electric Lighting. — Under the contract with the Boston Electric Light Company for lighting the Fens, such further extensions of the lighting along the Parkway as the commissioners should require were to be provided upon the same terms.

On Riverway there have been 7,433 feet of cable laid and 19 lamps erected; and in addition 1 incandescent lamp has been placed under the Bridle-path bridge. These lamps were first lighted on June 16.

Leverett Park.

Grading. — The work to be done under the contract with Moulton & O'Mahoney, dated November 28, 1891, was completed early in the year, and on April 27, 1894, a new contract was made with the same firm for doing such additional grading as was required and for building walls on Perkins and Chestnut streets. The grading has been completed.

The ledge on the line of the drive has been excavated and the stone from it used in surfacing roads and walks, and building walls and culverts. The stone-crusher which was set up for crushing stone from this ledge has been removed.

The slope above the wall on the line of the Nickerson estate has been graded and loamed and a fence erected on the top of the bank.

Practically all of the grading on this park is completed.

Bridges and Culverts. — A bridge has been built on the line of a foot-path across the outlet of the cove on the easterly side of Leverett pond. The bridge is a segmental arch of 24 feet span and 5 feet 5 inches rise; the width to outside of parapets is 18 feet 4 inches. The abutments are of concrete, faced with granite; the exposed face-work is of seam-face granite; the arch is of brick and the coping of red granite; the arch is 2 feet thick, covered with cement and a waterproof covering of tar and paper. The bridge was built by J. D. Fallon & Company, at a cost of $9,313.60.

The working plans were made from designs of the landscape architects, and Messrs. Shepley, Rutan, & Coolidge, architects.

Seven small culverts were built on the streams connecting the various ponds.

Retaining-walls and Steps. — Two walls of rustic masonry

were built by the department force on the slope above the cove on the easterly side of Leverett pond. The upper wall supports the bridle-path, while the lower wall supports a walk along the base of the upper wall.

The walls built under the contract with Moulton & O'Mahoney have been finished, with the exception of the cement top and the pointing. These walls are of Roxbury stone, and vary in height from 4 feet to 14 feet, the total length of the several sections being 1,368 feet; they serve to support Perkins street on its lower side and the banks on the upper sides of Perkins and Chestnut streets.

On April 20, 1894, a contract was made with James Killian for the construction of a wall on the easterly line of Chestnut street 351 feet in length, and also for a wall on the line of the Parkway adjoining the Nickerson estate 523 feet in length. This work has been completed at a cost of $9,327.06.

Mr. Killian has also built parapet walls and furnished and set coping on the walls built on the northerly side of Perkins street. This work is nearly finished.

Steps to the number of 300 were furnished by the Cape Ann Granite Company at a cost of $3,576. These have been set by the department force in places on the walks where they were needed.

Drainage and Water-pipes. — All of the drains and catch-basins required for this park have been built.

The lowering of the grade of Perkins street necessitated the lowering of the water-mains in that street. This work was done by the Water Department at the expense of the Park Department. An 8-inch pipe was also laid from the pumping-station through Chestnut and Perkins streets to Jamaicaway, it being a portion of the main for supplying water for the ponds in Franklin Park.

Drives, Ride, and Walks. — The drive from Pond avenue, near Willow pond, to Perkins street was surfaced early in the season, and opened to travel on June 1. On the same day Perkins street was closed for the purpose of lowering the grade of this street and also of Chestnut street. The change of grade of Perkins street involved cutting down the street at one point 13 feet. Both streets were widened at the same time to a minimum width of 45 feet. Chestnut street was closed on July 2, and was reopened on October 15. Perkins street was so far finished as to be opened to travel on December 20.

The drive from Tremont street to the entrance near Willow pond was not opened until November 18 on account of

the delay caused by cutting through the ledge, which required the removal of 7,696 cubic yards of rock.

The Bridle-path and a large part of the walks have been finished.

An Aveling & Porter compound steam road-roller was purchased in the spring for use on this park.

Plantations. — About 12 acres have been prepared for planting, of which about 3 acres have been planted.

Electric Lighting. — The electric lights were turned on for the first time June 29. There are 34 lamps and 14,500 feet of cable.

Jamaica Park.

Grading and Walls. — The work done by Saucier Bros., under their contract dated January 16, 1893, was completed on May 19, 1894, and there was paid them $32,504.36. The work done under this contract was the grading of all that portion of the park on the easterly side of the pond, excepting Pine Bank, from Perkins street to Prince street, including the widening of Pond street and the excavation of a cove on the shore of the pond nearly opposite Eliot street; it also included the grading of the part of Arborway between Prince and Centre streets, so far as the excavated material on the work would allow, and the building of a slope wall 920 feet in length along the Pond-street shore.

The north-westerly shore of the pond has been graded, from a point opposite Chestnut street nearly to Prince street, with gravel excavated from Perkins street.

Retaining-walls of a total length of 960 feet have been built around the cove before mentioned.

A flight of steps has been built leading from Perkins street opposite Chestnut street to Pine Bank.

Drainage and Water-pipe. — The necessary catch-basins and drains for the easterly side of the park have been built.

The water-pipe leading to Franklin Park has been laid through the whole length of the Parkway from Perkins street to Prince street.

Drives, Ride, and Walks. — The drive from Perkins street to Pond street was finished and opened to travel on June 1, and that along Pond street to Prince street was opened on June 16. The ride and the walks in this section of the park have all been surfaced, with the exception of the border walk between Perkins and Pond streets.

Plantations. — All of the areas to be planted have been graded and loamed in readiness for planting in the spring.

Electric Lighting. — Twelve lamps have been erected and

4,330 feet of cable laid. The lights were turned on on August 17.

Miscellaneous. — Work has been begun on the alteration of the dwelling-house at Pine Bank under the direction of the City Architect to adapt it for use as a refectory.

A new boat has been purchased for the use of the police.

The buildings on the Parkman estate have been removed, and the Ice Company buildings on Prince street are now being removed.

About 100 linear feet of seats for the use of skaters have been made. There has been skating on the pond 19 days during the year, and skating could have been enjoyed on many other days if funds had been available for caring for the ice. The police estimated the total attendance at 109,000.

Arborway.

Grading. — The section between Prince and Centre streets was graded under the contract with Saucier Bros., already referred to. The section between Centre and South streets was partially graded under a contract with Andrew Carberry, dated November 1, 1893, at a cost of $8,400.28. The balance of the grading was done by the department force and by contractors for furnishing labor by the day.

Drainage and Water-pipes. — A culvert 6 feet × 6 feet in section and 163 feet in length was built across the Parkway on the line of the brook which drains the Arboretum meadow.

All of the catch-basins and drains required on the whole length of Arborway have been built, except those on the traffic road between Centre and South streets, and on the section between South and Washington streets.

The water-pipe for Franklin Park has been laid between Prince and Centre streets and between Washington and Forest Hills streets.

Drives, Ride, and Walks. — The main drive and the ride have been surfaced for the whole length, except between South and Washington streets, it being impracticable to do any work on this section until the work of raising the grade of the railroad has been completed.

The drive was opened to travel on October 7. But little work has been done on the surfacing of the walks. No surfacing has been done on the traffic roads.

Electric Lighting. — Twenty-two arc lamps have been placed on Arborway, and 8,152 feet of cable laid. These lamps were first lighted on August 17.

Arboretum.

The land near the junction of Centre and Walter streets has been cleared and graded, and the boundary wall is now being extended around it.

Surveys have been made of the land belonging to Harvard College lying south of Bussey street, with reference to the contemplated addition of it to the Arboretum.

West Roxbury Parkway.

Preliminary surveys were made for three different lines of Parkway between the Main Park System and the Stony-brook reservation. Accurate surveys for the laying out of the section from the Arboretum to Weld street were made, and also of that portion of the Parkway laid out by the Metropolitan Park Commission between Weld street and Anawan avenue. Topographical surveys are now being made of the whole length of this Parkway.

Franklin Park.

Forest Hills Entrance. — On April 23 a contract was made with Charles H. Dodge for building the bridge which is to carry the Parkway over the traffic road leading from Forest Hills street to the Morton-street entrance to Forest Hills cemetery. This bridge has been completed with the exception of the cleaning and pointing of the masonry. The bridge is 126 feet in length, at a right angle with the Parkway, and is a segmental arch of 45 feet span and 6 feet rise, the springing line being 12 feet above the grade of the road beneath. All face-work is of seam-face granite, except the coping and cap-stones, which are of red granite, and the interior of the arch. The ashlar is laid as three-headed work. The foundation and backing are of cement concrete. The soffit of the interior of the arch is of light-colored brick, while the remainder of the arch is of common brick, the arch being 2 feet 8 inches thick. A staircase connects the walk over the bridge with the walk along the traffic road beneath. The slopes of the banks are supported by retaining-walls on the lines of the traffic road. Across the Parkway over the bridge the masonry piers for a gateway have been built. This gateway is to have three openings, — one each for the drive, the ride, and the walk. The piers at the sides of the gateway are connected with the parapets of the bridge, so that the whole forms one structure. At one side of the gateway there is a recess with a drinking-fountain and seats. The contract price for the bridge is $50,920.

The traffic road and the Parkway over the bridge are now being graded. The ledge at the junction of the Parkway with the Circuit drive is being removed, and the stone will be used for surfacing the Parkway. The drains and catch-basins are also being built.

Seaver Street. — The work of grading under the contract with H. P. Nawn, dated September 1, 1893, was completed on January 22, at a cost of $34,023.58. Another contract was made with Mr. Nawn for the removal of a portion of the ledge near Blue Hill avenue, the stone to be carted to the stone-crusher on the park, and when crushed to be carted back to Seaver street. Under this contract there were removed 3,221 cubic yards of rock, at a cost of $6,345.37.

The drive and walk within the lines of Seaver street, as laid out by the Street Commissioners, have all been surfaced, the surface-drains and catch-basins built, and the water-pipe relaid. The street was opened to travel throughout its whole length on December 24.

The street has a width of 60 feet, divided into a driveway 40 feet wide, a tree space 10 feet wide, and a sidewalk 10 feet wide.

A portion of the walk on the park, parallel with Seaver street, remains to be surfaced; also the entrance road opposite Elm Hill avenue.

Ellicott Cottage. — For the drainage of this building, it was necessary to build a sewer 2,260 feet in length, of 6-inch Akron pipe, through the park and Keyes street to Washington street. The grade being slight, a flush tank was built just outside the building, for flushing the sewer. The building is, as yet, provided with no method of lighting at night, and as no gas mains are near it will probably be necessary to use electricity.

Refectory. — This building is in process of erection under the direction of, and in accordance with, plans made by Messrs. Hartwell & Richardson, architects. The foundations are completed, and work is begun on the superstructure. The wall supporting the terrace in front of the building is being built of rustic masonry by the department force, and is nearly finished to the grade of the walk.

Water-supply. — It having been determined to obtain from Jamaica pond a supply of water for the ponds on Franklin Park, and for sprinkling the drives on the Parkway, pipes have been laid on a portion of the Parkway, as before described. Recently work has been begun on the construction of a reservoir on Hagborne hill, which will have a capacity of 883,000 gallons, with the surface of the water at grade 168 feet above city base. It is expected that this will fur-

nish a week's supply in the driest weather. It is not intended to use the water for drinking.

Pigeons. — On April 21 a donation of 128 pigeons, including a great variety of the most popular kinds, was received from the estate of the late Edmund Quincy, through Dr. H. P. Quincy. They have been placed in a loft prepared for them in the upper part of the propagating house at the Nursery, where they have attracted a great deal of attention.

Electric Lighting. — Nineteen arc lamps have been placed in the Playstead district and 16 on Seaver street. The lights were first used on September 22.

Miscellaneous. — The sheep now number 188, 73 having been sold in the fall.

Two buildings containing water-closets have been erected near the Columbia-street entrance to the park.

Scarboro' pond has been drawn down to its winter level, and the pond near Abbotswood has been filled, as heretofore, for skating; but owing to the proximity of the much larger and better place for skating at Franklin Field, these smaller areas have been but little resorted to this winter.

Franklin Field.

The work of grading and seeding the meadow was finished in September. On November 26 the water from the brooks was turned on to the field, flooding it to a depth of about 18 inches in the lowest part. The first skating was on December 24, and since that date the field has been resorted to by great numbers of people whenever the ice was in good condition. There has been skating on 20 days, and the total number of visitors on those days, as estimated by the police, has been about 66,000.

Dorchester Park.

A topographical survey of this park has been made. Two small buildings containing water-closets have been built.

Dorchesterway.

The filling between Buttonwood street and the railroad being done under the contract with Collins & Ham, dated February 20, 1893, is still in progress.

The drive and walks south of the northerly line of Pond street, and those at the junction of the Parkway and Buttonwood street, have been finished.

Strandway.

Filling. — A dump was opened in February for receiving material excavated from the land near the Institution for the Blind. During the year there have been delivered between I and M streets 67,118 cubic yards of filling, cart measurement, at 30 cents per cubic yard.

As the amount of dredging which should be done on the flats in front of the Strandway, between H and Q streets, is much larger than the space to be filled, it will not be economy to purchase filling, except such as can be used for forming the beach, or as a top-covering for mud filling after the latter is in place.

Plans are nearly completed for grading the section of the Strandway east of H street.

Marine Park.

Pier. — That portion of the wooden pier between the refectory and the site of the new head-house has been removed, and a plank-walk laid in its place.

Filling. — On July 27 a contract was made with William L. Miller for filling that portion of the park between the shore and the iron pier. This work is now in progress.

Drive and Walks. — The drive along the shore from the foot of Sixth street to the Castle-island bridge, and the entrance from Q street opposite Broadway, have been surfaced. The walk along the drive from Broadway to Sixth street has also been surfaced.

Drainage and Water-pipe. — Catch-basins and drains for draining the drive have been built. A water-pipe has been laid from Sixth street to the entrance to the pier and two hydrants set.

Electric Lighting. — Two thousand six hundred and eighty-three feet of underground cable have been laid, and four arc lamps erected on the portion of the park south of Broadway. The lamps were first lighted on September 5.

Building. — A building is being erected at the approach to the pier, under the direction of the City Architect. It is to contain a waiting-room for the public, toilet-rooms, a restaurant, and rooms for the police and workmen. In the rear of it there are to be 508 dressing-rooms for bathers. It is expected that this building will be completed ready for use during the coming season.

Miscellaneous. — The old wharf, left by a former contractor, was repaired, and a shelter built on the outer end of it; this was intended for use in connection with the boating service.

A flag-staff was erected near the Farragut statue, and the flag was raised for the first time on Memorial day with appropriate ceremonies by the Farragut Naval Veterans Association.

Castle Island.

The only work done here during the year, beyond the care of the grounds and buildings, has been the placing of 15 electric arc lamps.

As the location of these could be but temporary, overhead wires were run to them. They were first lighted on July 3.

Wood Island Park.

Grading. — The work under the contract with O'Connor and White, dated October 2, 1893, was completed on December 8, at a cost of $33,706.84. This work included all of the loam stripping and excavation required; the material excavated, however, was not sufficient to do all the filling needed; therefore, before the drives and a portion of the walks can be surfaced and the grounds fully made use of, additional filling will have to be obtained: this can be advantageously done by dredging from the flats within the park property.

Drainage and Water-pipes. — The sewers for draining the two buildings were completed on March 26, at a cost of $1,921.30.

A water-pipe has been laid from Neptune road to supply the field-house and men's gymnastic ground, and six hydrants have been set, four of them being within the gymnastic ground.

Buildings. — The section of the bath-house which was being built a year ago has been completed. This building, so far as built, contains a waiting-room, a locker-room, and a toilet-room. It has been connected with the sewer, but has not as yet been supplied with water, as the grounds near it have not been graded.

The Field-house has been finished. This building is for the use of men and boys only, although during the present skating season women and girls have been allowed to use a portion of it; this can be readily done in winter, as the locker-room and small toilet-room adjoining it are not otherwise in use when the gymnasium is not in operation.

The building is of one story, 130 feet long by 26 feet wide; there is a waiting-room and toilet-room for men and boys, a room for the superintendent of the gymnasium, a large dressing-room provided with 170 lockers, for the convenience of those using the gymnasium, and a bath-room,

with shower and needle baths; there is also a boiler-room, the building being warmed throughout by hot water.

The building is lighted by incandescent electric lights.

Both of these buildings were built under the direction of Messrs. Sturgis & Cabot, architects.

Gymnastic Ground. — On October 10 a contract was made with the Van Dorn Iron Company of Cleveland, Ohio, for the erection of an iron fence around this ground and for the frames for the gymnastic apparatus. The fence has been erected and the frames are on the ground ready for erection as soon as the frost leaves the ground.

Skating. — The gymnasium and playgrounds have been flooded during the present winter, and there has been skating on 25 days, the attendance, as estimated by the police, being about 88,000. The Field-house has been opened on days when there was skating.

Charlestown Heights.

The building for the accommodation of the public has been finished, and only needs lighting to be ready for use. This building is of two stories, with a cellar under a portion of it, which contains the heating-apparatus. The first story contains toilet-rooms for both sexes, a room for the person in charge, and rooms for the police and workmen. There is a tool-house adjoining the main building. The second story is an open shelter, a band-stand being located on that portion towards Bunker Hill street.

The building was built under the direction of Messrs. Walker & Kimball, architects.

Four electric arc lights have been placed upon the grounds and 50 settees purchased.

Charlestown Playground.

Nothing has been done at this ground during the year except to supervise the dumping of ashes and earth.

A considerable area of the ground is now filled.

Charlesbank.

Men's Gymnasium. — During the winter months the grounds have been used for skating when the weather was favorable. The number of days on which there was skating was 22, and the average attendance on those days was 2,911.

The gymnasium was closed on March 1, and the apparatus and grounds put in thorough repair. It was reopened on May 18, and closed November 30. During the season it was open for gymnastic and athletic exercises on 155 days,

Principal items of work completed on the several Parks to January 31, 1895.

	Main Park System						Marine Park System							
	Back Bay Fens	Riverway	Leverett Park	Jamaica Park	Arborway	Arnold Arboretum	Franklin Park	Dorchester Bay	Marine Park	Castle Island	Charlestown Park	Wood Island Park	Charlestown Heights	Franklin Field	Totals.
Drive-ways completed	87,600 sq. yds 4 miles	2,388 sq. yds 1.2 miles	2,750 sq. yds 1.2 miles	13,244 sq. yds 0.7 mile	24,050 sq. yds 1 mile	6,488 sq. yds 2.3 miles	311,572 sq. yds 7.6 miles	4,620 sq. yds 0.2 mile	17,883 sq. yds 0.8 mile						539,887 sq. yds. 18.7 miles.
Walks completed	26,000 sq. yds 3.1 miles	12,000 sq. yds 1.5 miles	10,427 sq. yds 1 mile	9,731 sq. yds 1 mile	1,100 sq. yds 0.1 mile	10,178 sq. yds 4.2 miles	66,067 sq. yds 9.7 miles	1,883 sq. yds 0.1 mile	2,094 sq. yds 0.3 mile		14,452 sq. yds 1.5 miles		4,041 sq. yds 0.4 mile.		199,070 sq. yds. 23.9 miles.
Ride completed	14,400 sq. yds 1.1 miles	17,400 sq. yds 1.4 miles	12,900 sq. yds 0.9 mile.	9,861 sq. yds 0.7 mile	17,920 sq. yds 1.2 miles	. . .	10,488 sq. yds 0.7 mile	. . .	. . . . .		. . . . .				81,781 sq. yds. 5.85 miles.
Granite paved	19,000 sq. yds	8,800 sq. yds	900 sq. yds	3,480 sq. yds	7,140 sq. yds	8,060 sq. yds	22,200 sq. yds	780 sq. yds	2,921 sq. yds		. . . .				73,861 sq. yds.
Curbstones set	2,945 lin. ft	1,165 lin. ft	2,028 lin. ft	2,220 lin. ft	. .	. .	9,630 lin. ft	808 lin. ft	1,297 lin. ft		. .		125 lin. ft.		20,351 lin. ft.
Water-pipe, 12 in	10,030 lin. ft	812 lin. ft	. . . . .	. .	. .	. .	200 lin. ft	.	.		. .	1,332 lin. ft			12,370 lin. ft.
" 10 in	. . . . .	. . . .	324 lin. ft	1,100 lin. ft	. .	. .	. .	. .	844 lin. ft		. . .				2,767 lin. ft.
" 8 in	2,42 lin. ft	. . .	1,020 lin. ft	1,395 lin. ft	1,160 lin. ft	. .	. .	. .	17 lin. ft		.	1,179 lin. ft.			7,215 lin. ft.
" 6 in	1.7 lin. ft	.	1,400 lin. ft	. .	. .	. .	4,145 lin. ft	. .	27 lin. ft		50 lin. ft	118 lin. ft.			5,467 lin. ft.
" 4 in	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. .	1,078 lin. ft.	. . . .	. . .		. . . .	353 lin. ft.			1,951 lin. ft.
Hydrants	44	. . . .	2	.	.	.	12	. .	2		1	7			68
Drinking fountains	. . . .	. . . .	. . . .	. .	. .	. . . . .	9	. .	1	2	5	1	1		19
Watering trough for horses	. . . .	. . . .	. . . .	. .	. .	. .	1	. . . .	.		.				1
Brick drains, 4 ft 6 in	.	.	. . .	1,416 lin. ft	. .	. . . . .	. . . . .								1,416 lin. ft.
" " 2 ft. 9 in	. . . .	. . . .	. . . .	. .	. .	. .	706 lin. ft	. . .							706 lin. ft.
" " 2 ft + 2 ft 6 in	. . . .	. . . .	. . . .	. .	. .	. .	180 lin. ft	. .							180 lin. ft.
" " 2 ft 6 in	. . . .	. . . .	. . . .	. . . .	. .	. .	859 lin. ft	.						1,500 lin. ft.	2,359 lin. ft.
Pipe drains, 18 in	. . .	. . .	312 lin. ft	. . . .	. . .	73 lin. ft	3,440 lin. ft	. .				561 lin. ft			4,728 lin. ft.
" " 15 in	778 lin. ft	. .	. .	702 lin. ft	24 lin. ft	298 lin. ft	2,804 lin. ft	. .				196 lin. ft.		977 lin. ft.	6,139 lin. ft.
" " 12 in	4.2 lin. ft	. .	. . . .	540 lin. ft	46 lin. ft	62 lin. ft	2,024 lin. ft	. .				139 lin. ft		976 lin. ft.	5,055 lin. ft.
" " 10 in	820 lin. ft	.	294 lin. ft	474 lin. ft	1,864 lin. ft	467 lin. ft	2,004 lin. ft	.				406 lin. ft.	223 lin. ft	1,501 lin. ft.	8,011 lin. ft.
" " 8 in	6,852 lin. ft	3,956 lin. ft.	4,302 lin. ft	418 lin. ft	1,506 lin. ft	2,041 lin. ft	9,248 lin. ft.	765 lin. ft	1,474 lin. ft		1,469 lin. ft	2,583 lin. ft.	584 lin. ft	245 lin. ft	36,100 lin. ft.
" " 6 in	264 lin. ft	232 lin. ft	. .	. .	1,420 lin. ft	.	2,144 lin. ft	. .	. .		. .	. .	182 lin. ft		4,612 lin. ft.
" " 4 in	. . . .	. . . .	. . . .	. . . .	. . . .	. .	190 lin. ft	. .	. .		. .	. .	. .		190 lin. ft.
Agricultural tile drains, 4 in	.	.	240 lin. ft	. .	.	.	2,570 lin. ft	. .						185 lin. ft.	2,995 lin. ft.
" " " 3 in	. . . . .	. . . .	. . . .	. . . .	. . . .	5,066 lin. ft	1,420 lin. ft.	. .					328 lin. ft		6,913 lin. ft.
" " " 2 in	. . . .	. . . .	. . . .	. . . .	. .	2,353 lin. ft	20,785 lin. ft	. .				3,199 lin. ft		6,969 lin. ft	39,214 lin. ft.
" " " 1½ in	. . . .	. . . .	. . . .	. .	3,125 lin. ft	3,430 lin. ft	27,170 lin. ft	. .				1,547 lin. ft.		44,028 lin. ft.	79,580 lin. ft.
Total drains	9,154 lin. ft.	4,288 lin. ft.	4,948 lin. ft.	1,994 lin. ft.	10,956 lin. ft	13,063 lin. ft	81,753 lin. ft	765 lin. ft.	1,474 lin. ft.		1,469 lin. ft.	8,539 lin. ft.	1,317 lin. ft	59,711 lin. ft.	201,428 lin. ft.
Flush-tank	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	1	. .	. .		. .	. .	. .	. .	1
Manholes	10	2	6	6	9	2	89	1			14	10	3	7	136
Catch basins and inlets	107	50	41	18	36	63	186	6	11		19	13	10	10	579
Open channel for brook	. .	. .	. .	.	.	. .	2,300 lin. ft	. .	. .		. .	. .	. .	3,530 lin. ft.	5,830 lin. ft.
Electric-light cable	18,850 lin. ft	7,445 lin. ft	11,400 lin. ft	4,350 lin. ft	8,152 lin. ft	.	13,865 lin. ft	. .	2,683 lin. ft		. .	. .	. .	. .	66,856 lin. ft.
Electric lights	51	20	33	12	22	. .	56	. .	10	33	13	. .	4	. .	253
Gateways	. . . . .	. . . . .	. . . . .	. . . . .	. .	. .	4	. .	. .		. .	. .	. .	. .	4
Bridges and culverts*	8	6	12	.	2	4	5	. .	1 iron pier	1	. .	1	. .	. .	40
Boundary wall	. . . .	. . . .	. . . .	. . . .	. .	804 lin. ft	4,468 lin. ft	. .	. .		2,228 lin. ft.	. .	512 lin. ft.	. .	8,008 lin. ft.
Buildings	1	1	1	. .	. .	. .	9	. .	1		2	2	1	. .	16
Flag staffs	. . . .	. . . .	. . . .	. .	. .	. .	1	. .	1		. .	. .	. .	. .	2
Area of ground finished	106 acres	35 acres	41 acres	13.2 acres.	10.6 acres	155 acres.	240 acres	1.5 acres.	15.4 acres		10 acres	2.4 acres.	3.4 acres.	42 acres	773.5 acres.
Flumes	. . . .	. . . .	. . . .	. .	. .	. .	. .	. .	. .		. .	. .	. .	2	2
Retaining wall	688 lin. ft	46 lin. ft.	2,343 lin. ft	1,524 lin. ft	.	. . . .	3,171 lin. ft.	. .	. .		. .	. .	. .	. .	8,272 lin. ft.
Slope wall	. . . .	. . . .	. . . .	1,171 sq. yds.	. .	. . . .	. .	. .	. .		. .	. .	. .	. .	1,171 sq. yds.
Gate-chambers	1	1	.	1	. .	. . . .	. .	. .	. .		. .	3	. .	. .	6
Under track	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. .	. .	. .		2,821 sq. yds 0.2 mile	. .	. .	. .	2,821 sq. yds. 0.2 mile.
Fence	8,750 lin. ft	. . . .	. . . .	. . . .	. . . .	. . . .	. .	. .	. .		3,412 lin. ft.	1,345 lin. ft.	. .	. .	13,507 lin. ft.

* Eight of these bridges are partly in Brookline.

with a total attendance of 160,596, or a daily average of 1,036, an increase of 175 over the previous year.

On account of the removal of the old building preparatory to the erection of a new one the gymnasium was not open in December.

A new building is now being erected under the direction of the City Architect, which will afford much larger accommodations and provide facilities for dressing, bathing, etc., which facilities are a necessity for the success of a gymnasium.

Only one accident occurred during the year: a boy was struck by the 16-pound shot, he having carelessly run across the ground reserved for shot-throwing; his ankle was broken. In the future it will be well to have the spaces devoted to putting the shot enclosed by fences.

Women's Gymnasium and Girls' Playground. — These were reopened on May 21, and closed on October 31. As in previous years, they were in charge of the Massachusetts Emergency and Hygiene Association, whose report to the Park Commissioners contains all matters of interest concerning the work.

The building at this ground having proved inadequate for the purpose for which it was designed, an addition is now being built which will double the accommodations and furnish facilities for bathing and dressing which have been wanting in the past. Walker & Kimball, architects, have charge of the work.

Miscellaneous. — The grounds other than the gymnasiums are in good condition, except that the promenade along the river has become worn and should be resurfaced.

North End Park.

Early in the year the old buildings were removed, and on July 12 a contract was made with William L. Miller for the removal of the old wharves, etc. This work was finished on September 20, at a cost of $3,400. Plans are now being prepared for the construction of that portion of the park between Charter and Commercial streets.

Brighton Playground.

A survey was made of this ground for the purpose of determining its area and boundaries.

The appended table shows the principal items of work completed to date on the several parks, so far as it is practicable to tabulate them.

A large amount of other work has been done, which it is impossible to classify.

E.

[FROM THE CITY ENGINEER'S REPORT TO THE STREET DEPARTMENT.]

The following is a report of the work done under my direction for the Street Department during the year 1894.

The following are the principal items of work done:

Block-stone paving, on a concrete base, laid with pitch joints, 12,349.5 square yards, at an average cost of about $4.75 per square yard.

Block-stone paving, on a gravel base, laid with pitch joints, 5,410 square yards, at an average cost of about $3.50 per square yard.

Block-stone paving, on a gravel base, with gravel joints, 34,617 square yards, at an average cost of about $3.00 per square yard.

Trinidad sheet asphalt, with a binder course of asphaltic cement concrete, on a concrete base, 4,577.6 square yards, at an average cost of about $3.75 per square yard.

Sicilian rock asphalt, on a concrete base, 2,392.5 square yards, at an average cost of about $3.75 per square yard.

Edgestone set, 48,678 lin. ft.; brick sidewalk laid, 17,119 square yards; flagging crosswalk laid, 2,361 square yards.

The following is a statement of the streets paved, for which plans were made, lines and grades given, and the work supervised:

Albany Street. — From Broadway to Lehigh street was paved with old granite blocks on a gravel base; the blocks used were the best of those removed from Charles street; the street was sub-graded and the gutters removed by P. F. Lonergan; the paving, resetting of edgestone, and relaying of brick sidewalks was done by the Paving Division. The surface removed was macadam.

Arlington Street. — From Beacon to Marlborough street was paved with vitrified brick on a concrete base; the street was sub-graded by J. J. Sullivan, the gutters removed by James Dolan; the concrete base was put down and street paved by The Interstate Vitrified Brick and Paving Company, of New Jersey, at their own cost. The edgestones were reset and the brick sidewalk relaid by James Grant & Co. The surface removed was macadam.

Austin Street (Charlestown). — From Washington street to Fitchburg Railroad crossing was paved with granite blocks on a gravel base; the sub-grading was done by the Paving Division. The street was paved, the edgestones reset, the brick sidewalk and the crosswalks relaid by John Turner & Co. The surface removed was old granite blocks.

Barton Court. — From Barton to Brighton street was paved with Trinidad asphalt, with a binder layer of asphaltic cement concrete on the existing cobble-stone pavement, by the Barber Asphalt Paving Company.

Blue Hill Avenue. — From Dudley street to 80 feet north of Dalmatia street was paved with large granite blocks on a gravel base; the sub-grading was done by the Paving Division. From Dudley to Moreland street the street was paved, the edgestone reset, and the brick sidewalks and crosswalks relaid by the Paving Division.

From Moreland street the paving was done by D. N. Payson. Two new catch-basins were built on the easterly side, one at Stafford street and one at Devens street. The surface removed was macadam.

Bowker Street. — From Chardon to Sudbury street was paved with large granite blocks on a gravel base, with pitch joints. The old pavement was removed and the street was sub-graded by the Paving Division. The street was paved, the edgestones reset, and the brick sidewalks relaid by James Grant & Co. The West End Street Railroad Company, by agreement, paid for an amount of paving equivalent to the area previously occupied by their tracks. The pavement removed was cobble-stone.

Cambridge Street. — From Joy street to Bowdoin square was paved with large granite blocks on a concrete base, with pitch joints; the old block pavement was removed, and sub-grading done by S. & R. J. Lombard: the blocks and material excavated became the property of the contractor. The concrete base was put down by the Metropolitan Construction Company, the street was paved, the edgestones reset, and the brick sidewalks and granite flagging crosswalks relaid by H. Gore & Co. The West End Street Railway Company agreed to pay for the work done between the rails of their tracks, which work was done in a similar manner to the rest of the street, by H. Gore & Co. The pavement removed was old granite blocks.

Causeway Street. — From west side of Nashua to east side of Haverhill street was paved with large granite blocks on a concrete base; the sub-grading was done by the Paving Division, the concrete base was laid by the Metropolitan Construction Company, the street was paved, the edge-

stones reset, and the brick sidewalks and granite flagging crosswalks relaid by J. Grant & Co.

There were four new catch-basins built on the northerly side of the street. The pavement removed was old granite blocks. The roadway was widened on the northerly side about 10 feet, by removing the old brick sidewalk, and using the space in front of the new Union Station for a sidewalk; the roadway was also improved by removing one of the West End Railway tracks between Portland street and Canal street and moving the other track over to the northerly curb. A granolithic sidewalk was laid in front of the old Lowell Station by the Warner H. Jenkins Company.

Chambers Street. — From Green to Poplar street was resurfaced with Trinidad asphalt on the old cobble-stone pavement by the Barber Asphalt Paving Company. The surface removed was old Trinidad asphalt.

Chapman Street (Charlestown). — From Austin street to Rutherford avenue was paved with large granite blocks on a gravel base, the bed was prepared by the Paving Division, the street was paved, the edgestones reset, and the brick sidewalks and flagging crosswalks relaid by J. Turner & Co. The pavement removed was old granite blocks.

Charles Street. — From Pinckney to Cambridge street, on the westerly side, except in front of the Eye and Ear Infirmary, was paved with large granite blocks laid with pitch joints on a concrete base; the old pavement was removed and the street sub-graded by P. O'Riordan and by the Paving Division. The best of the old blocks were used on Albany street, from Broadway to Lehigh street. The concrete base was laid by the Metropolitan Construction Company. The paving, including the westerly track of the West End Street Railway, the edgestone resetting, the brick sidewalk and granite flagging crosswalk relaying was done by F. H. Cowin. The West End Street Railway by agreement paid for the work done in their track. It was intended to pave the street in front of the Eye and Ear Infirmary with Sicilian rock asphalt, but on account of unfavorable weather the work had to be postponed; this part of the street was made passable by putting in crushed stone temporarily. The pavement removed was old granite blocks.

Charter Street. — From Hanover to Unity street was surfaced with 3½ inches of Trinidad asphalt and binder on the cobble-stone base by the Barber Asphalt Paving Company; the cobble-stone base was regulated, the edgestones reset, and the brick sidewalk and flagging crosswalks relaid by James Grant & Co. The former pavement was cobble-stone.

Court Square. — The easterly and southerly roadways were resurfaced with Trinidad asphalt and binder on a concrete base by the Barber Asphalt Paving Company. The old concrete base having been found to be poorly graded, and it not being deemed expedient to relay the same, considerable extra work had to be done in order to shape the binder so as to give a proper crown to the street.

Commonwealth Avenue. — From Arlington street to Massachusetts avenue, see page 131.

Dartmouth Street. — From Boylston street to Newbury street was paved with Trinidad asphalt on a concrete base by the Barber Asphalt Paving Company. The sub-grading was done by J. J. Sullivan; the concrete base was laid by the Metropolitan Construction Company. The edgestone was reset in part and the brick sidewalk relaid by H. Gore & Co. The original intention was to pave the street from curb to curb with asphalt, but the West End Street Railway was allowed to pave with granite blocks between the rails of their track, until the horse cars now running there are replaced by electrics. The former surface was macadam.

Derne Street. — From Hancock to Temple street was paved with Hastings asphalt blocks on a base of crushed stone, by J. Turner & Co. The sub-grading was done, the edgestone was reset (north side), and the brick sidewalk (north side) was relaid by J. Turner & Co. The cobble-stone, old edgestone, and material excavated became the property of the contractor. On the southerly side of the street the State House Commissioners put in a combination granite curb and gutter and a granolithic sidewalk. One catch-basin was rebuilt at the corner of Hancock street. The former pavement was cobble-stone.

East Eighth Street. — From Old Harbor to G street (north side) and G to H street, on both sides of the railroad track, was paved with large granite blocks on a gravel base. The sub-grading was done by the Paving Division, and the street paved, edgestones reset, brick sidewalk and flagging crosswalks relaid by H. Gore & Co. The former surface was macadam.

East Second Street. — From I to K street was paved with large granite blocks on a gravel base; the sub-grading was done by the Paving Division, and the street paved, edgestone reset, brick sidewalk and flagging crosswalk relaid by H. Gore & Co. The former surface was macadam.

Essex Street. — From Harrison avenue to Kingston street was paved with large granite blocks on a gravel base, with pitch joints; the sub-grading was done by the Paving Division, and the street paved, edgestone reset, brick sidewalk

and flagging crosswalk relaid, by Doherty & O'Leary. The former pavement was old granite blocks. The street was widened to a uniform width of fifty feet.

Essex Street. — From Kingston to South street was paved with large granite blocks on a gravel base, partly with pitch joints and partly with gravel joints. The sub-grading was done by the Paving Division, and the edgestone reset, brick sidewalks and flagging crosswalks relaid, by A. A. Libby & Co. The former pavement was old granite blocks. This street was widened to a uniform width of fifty feet.

Fay Street. — From Dover street to Harrison avenue was surfaced with Sicilian rock asphalt on the existing cobble-stone pavement, by H. Gore & Co. This work was commenced in 1893. (See report of Superintendent of Streets for 1893.)

Harrison Avenue. — From Beach to Essex street; from Beach street 200 feet toward Essex street was paved with large granite blocks on a concrete base with pitch joints. The rest of the street was paved temporarily until the West End Street Railway can obtain and put in new special work. The concrete base was put in by the Metropolitan Construction Company; the rest of the work was done by the Paving Division. The work done was necessitated by the widening of the avenue. The former pavement was old granite blocks.

Lewis-Street Extension. — From North to Moon street was paved with granite blocks on a gravel base. The sub-grading was done by the Paving Division, and the paving was done, edgestone set, brick sidewalk and flagging crosswalks laid, by P. W. Hernon. One new catch-basin was built at the corner of North street. This extension was laid out in 1893.

Mason Street. — At Boston and Bijou theatres was surfaced with Sicilian rock asphalt on cobblestone base with binder, by H. Gore & Co. The base was regulated, the edgestone reset, and the brick sidewalks relaid by Paving Division. The former pavement was cobble-stone.

Massachusetts Avenue. — The southerly roadway, from Washington to Albany street, was to have been surfaced with Sicilian rock asphalt on a concrete base by H. Gore & Co., but only about 275 feet from Washington street was laid, when the weather became so unfavorable on account of the lateness of the season, that work had to be suspended. The excavating to sub-grade and removing of gutters was done by J. J. Sullivan. The concrete was put down by the Metropolitan Construction Co.; the edgestones reset and the brick sidewalk relaid by H. Gore & Co. A granolithic sidewalk in front of the City Hospital building was laid by

Simpson Bros. The centre parkway was extended about 130 feet to within 16 feet of Albany street, and a driveway was built across it opposite the entrance to the Hospital. The uncompleted roadway between Washington street and Harrison avenue was made passable by covering the concrete with crushed stone; the part between Harrison avenue and Albany street was closed to travel, and the concrete covered with sea-weed to protect it from the frost. Nine new catch-basins were built between Harrison avenue and Albany street, — four on the northerly roadway and five on the southerly roadway, — and one was rebuilt at the corner of Albany street. The former surface was macadam.

Park Street and City Square, Charlestown. — The paving on this street, which was not completed in 1893, was finished in April of the present year.

Pemberton Square. — In front of the new Court House was surfaced with Sicilian rock asphalt on a concrete base, by H. Gore & Co. In the southerly corner, where the teams of Houghton & Dutton are loaded, the square was paved with large granite blocks on gravel base with pitch joints, by J. Grant & Co. The concrete base was laid by the Metropolitan Construction Company. The excavation to sub-grade was done by the Paving Division; the old gutter paving removed by J. Dolan; the edgestone reset by J. Grant & Co.; a granolithic sidewalk was laid on the westerly side of the square, and on part of the easterly side, by Simpson Bros.; and five new catch-basins were built. The former pavement was macadam. The old planting space in the square, containing four trees, was removed, the edgestone in front of the Court House was laid out in a circular arc, very nearly concentric with the edgestone on the opposite side of the roadway, making a roadway about 36 feet wide; at the back of the sidewalk was placed a curb of special design, between which and the building it is intended to make a grass plot.

Ruth-Street Extension. — This way or foot-path is in East Boston, and serves to connect Webster street and Marginal street, which are parallel streets, about 240 feet apart, but with a difference of level at this point of about 45 feet. The extension is about 138 feet long and 11½ feet wide. It consists of 7 flights of artificial stone steps connected by platforms of the same material. An additional flight of 13 steps connects Brigham street with Ruth street. The artificial stone work was done by Simpson Bros., at a cost of $2,122.93. The iron railing and fence work was furnished by G. T. McLauthlin & Co., and cost $554.97. The excavation, foundations, stone retaining-walls, and wooden fences were furnished by the Street Department. This is the first

example of the use of "artificial stone" on any considerable scale that the city has yet made. It is used here for walks, steps, and retaining-walls. It makes a fine-looking job, and thus far the experience has been satisfactory.

Utica Street. — From Kneeland street to the angle was paved with large granite blocks on a gravel base, by the Paving Division. About 350 square yards of the old cobble-stone were removed by J. Dolan, the rest by the Paving Division. The edgestone, brick sidewalks, and crosswalks were relaid by the Paving Division. One new catch-basin was built. The former pavement was cobble-stone.

Washington Street. — From Essex to Eliot street was paved with large granite blocks on a concrete base with pitch joints, by H. Gore & Co. The old block paving was removed to Commonwealth avenue beyond Harvard avenue, by O. Doherty. The sub-grading was done by the Paving Division, and the edgestone reset, brick sidewalks and granite flagging crosswalks relaid, by H. Gore & Co.

The West End Street Railway, by agreement, paid for the work done between the rails, which work was done in a similar manner to the rest of the street. Two new catch-basins were built. The former pavement was old granite blocks.

Grading Street-Railway Tracks.

The work of properly grading street-railway tracks to fit a permanent surface of the street has been continued. This requires much labor, and it seems proper that the railway company should bear a portion of the cost of so doing. This has been arranged by requiring a survey of the street surface, with levels, to be made by the railroad engineers in all cases where street construction work has not been ordered by the Street Department. The grades for the tracks are then established and blue-prints of the working plans are furnished the railroads.

The following tracks have been graded:

West End Street Railway.

Bowdoin Street. — From Washington street to Geneva avenue.

Cambridge Street. — From Joy street to Bowdoin square.

Causeway Street. — From Billerica through Haverhill street.

Centre Street. — From Cedar to Pynchon and Cedar to Eliot square.

Central Square. — East Boston.

Charles Street. — From Pinckney to Cambridge street.

Clarendon Street. — Across Commonwealth avenue.

Commonwealth Avenue. — From Beacon street to Cottage Farm bridge and St. Paul street to near Malvern street.

Dartmouth Street. — From Boylston to Newbury street and across Commonwealth avenue.

Dover Street. — From 200 feet west of Albany street to Dover-street bridge.

Eagle Street. — From junction of Lexington street to new car-house.

Essex Street. — From Harrison avenue to Kingston street.

Harrison Avenue. — From Essex to Beach street.

Huntington Avenue. — From 2,950 feet south of Gainsborough to Tremont street.

Lexington Street. — From Meridian to Marion street.

Lexington Street. — From Eagle to Prescott street.

Meridian Street. — From Central square to Chelsea street.

Prescott Street. — From Lexington to Saratoga street.

Tremont Street. — At Huntington avenue.

Warren Street. — From Elm Hill avenue to Brunswick street.

Washington Street. — From Boylston to Hollis street and Boston & Albany Railroad bridge to Warrenton street.

West Fourth Street. — From Dover-street bridge through Dorchester avenue.

Norfolk Suburban Street Railway.

Hyde Park Avenue. — From Hyde Park line to Forest Hills.

Quincy & Boston Street Railway.

Neponset Avenue. — At Neponset bridge.

Surveys, plans, and estimates for improving and paving the following streets have been made: construction not yet commenced:

Albany Street. — From old East Springfield to Northampton street.

Arlington Street. — From Marlborough through Commonwealth avenue.

Ash Street. — From Oak to Nassau street.

Austin Street. — From Fitchburg Railroad crossing to Prison-point bridge.

Bartlett Street. — From Washington street about 500 feet westerly.

Bennington Street. — From Wordsworth to Saratoga street.

Chelsea Street. — From Bennington to Saratoga street.

Congress Street. — From Atlantic avenue to Congress-street bridge.

Court Avenue. — And Corn Hill court.

Dartmouth Street. — From Warren avenue to Columbus avenue.

Harrison Avenue. — From Beach to Kneeland street.

Harrison Avenue. — From Dudley to Warren street.

Harrison Avenue. — From East Springfield to Northampton street.

Massachusetts Avenue. — From Washington to Albany street (northerly roadway).

Merchants Row. — From State to South Market street.

Milk Street. — From Washington to Congress street.

Northampton Street. — From Harrison avenue to Albany street.

North Margin Street. — From Cooper to Stillman street.

Norway Street. — From Massachusetts avenue to Falmouth street.

Oxford Street. — From Beach to Essex street.

State Street. — From Merchants row to India street.

Washington Street. — From Hollis to Boston & Albany Railroad bridge.

Water Street. — From Washington to Devonshire street.

MISCELLANEOUS WORK.

Essex and Lincoln Streets. — On February 7, 1894, a contract was made with A. A. Elston to take down the old building standing upon the widening of the above-named streets, and upon the estate of John Farlow, for the sum of $1,425, which work was satisfactorily completed.

West End Street Railroad Co. — The tracks of the above company were removed from the following streets, and the cost of repaving the same with granite blocks on a gravel base with pitch joints was paid by the company. Measurements of the areas of paving, to be so paid for, were made and returned.

Bowker Street. — From Chardon to Sudbury street.
Broad Street. — From Wharf to Franklin street.
Fleet Street. — From Hanover to Commercial street.
Foundry Street. — From Division to W. Fourth street.
Franklin Street. — From Broad through Congress street.
High Street. — From Engine-house to Oliver street.
Milk Street. — From Oliver to Congress street.
Oliver Street. — From High to Milk street.

Surveys and plans were made for work upon the following

streets; grades and lines were given, but the work of construction was not supervised by this department:

Dartmouth Street. — From Tremont street to Warren avenue was paved with old granite blocks from Dover and Albany streets: a plan was prepared and lines and grades given for paving, resetting edgestones, relaying brick sidewalks and flagging crosswalks, the work being done by the Paving Division. The West End Street Railway tracks were not regraded. The former surface was macadam.

Tufts Street. — From Kingston to Lincoln street was repaved with granite blocks, gravel base. A plan was prepared and lines and grades given. The work of paving the roadway, resetting the edgestone, relaying the brick sidewalks and flagging crosswalks, was done by the Paving Division.

Rutherford Avenue. — From Devens to Chapman street was paved with granite blocks on gravel base. A plan was made and lines and grades given. The work of paving, resetting edgestones, relaying brick sidewalks and flagging crosswalks, was done by the Paving Division. The former surface was macadam. One new catch-basin was built and three old ones rebuilt.

Thompson Street. — From Main to Warren street was macadamized. A plan was made and lines and grades given. The work of macadamizing, resetting edgestones, relaying brick sidewalks, was done by the Paving Division. The former pavement was cobble-stone.

Phipps Street (Charlestown). — Was paved with granite blocks on gravel bed. A plan was prepared and lines and grades given. The work of paving the roadway, resetting edgestones, relaying brick sidewalks, was done by the Paving Division. The former pavement was cobble-stone.

Charles Street. — From Main to Bunker Hill street was paved with large granite blocks on a gravel base; lines and grades were given. The work of paving the roadway, resetting the edgestone, relaying brick sidewalks, was done by the Paving Division. The former surface was cobble-stone.

Sprague Street. — From Princeton to Bunker Hill street was macadamized. The edgestone was set, cobble gutters and brick sidewalks were laid by the Paving Division. The former pavement was gravel.

Oak Street. — From Washington street to Harrison avenue was paved with granite blocks on a gravel base. A plan was prepared and lines and grades given. The work of paving roadway, resetting edgestone, relaying brick sidewalks and flagging crosswalks, was done by the Paving

Division. The former pavement was blocks and cobble-stone mixed.

Utica Street. — From Kneeland to Beach street was paved with granite blocks on a gravel base. A plan was made and lines and grades given. The work of paving the roadway, resetting edgestone, and relaying brick sidewalks was done by the Paving Division. The former pavement was old granite blocks.

Congress Street. — From A street to L-street bridge. The work on the plank sidewalk and fence, which was begun last year, has been completed.

Bushnell Street (called Peabody Square). — A plan was made showing the present and proposed location of trees; a plan and specification was also prepared for a circular park curb, and lines and grades given for setting the same. The work was done by the Paving Division. One catch-basin and one drop inlet built.

Vale Street. — From Dorchester street to Mercer street. Cross section and an estimate were made for filling the above to grade, and lines and grades given for filling the same.

Preliminary estimates were made for repairing or rebuilding ninety streets.

New Streets.

During the early part of the season of 1894 three streets, viz., Miner street, Bay State road, and Deerfield street, which were reported last year as uncompleted, were finished. The following streets have been contracted for, under the provisions of Chap. 323 of the Acts of the Legislature of 1891, as amended by Chap. 418 of the Acts of 1892; the entire expense of construction is borne by the abutter, and sewer, gas, and water pipes, with house connections to the sidewalk, are laid in advance of the street construction:

Arundel Street. — From Beacon to Mountfort street, about 271 feet long, is practically completed at a total cost of $1,843.45. For itemized prices and quantities, see table accompanying this report. The contractors were H. Gore & Co. It is a 6-inch macadam street.

Ivy Street. — From St. Mary to Mountfort, not including the Audubon-road intersection, is about 772 feet long. This contract, which was awarded to J. Grant & Co., is not yet completed, and there remains to be done the spreading of the binder, watering, and rolling. It is a 6-inch macadam street.

Mountfort Street. — From Audubon road to Ivy street, is about 427 feet long. This street was constructed by H.

Gore & Co., at a cost of $2,549.93. It is a 6-inch macadam street.

Newbury Street. — From Charlesgate West to Brookline avenue, about 1,271 feet in length, was built by F. H. Cowin & Co., at a total cost of $10,386.93. This is a 6-inch macadam street.

Parker Street. — The contract for constructing and regulating this portion of this street from Huntington avenue to Westland avenue, about 1,687 feet long, was awarded to Messrs. Doherty & O'Leary. The work is not yet finished. It is to be a Telford roadway, the base to be 10 inches, and the broken stone 6 inches, in thickness.

St. Germain Street. — The contract for building St. Germain street, from Massachusetts avenue to Dalton street, about 749 feet long, was awarded to Quimby & Ferguson, but on account of the lateness of the season they were able to do only the filling to sub-grade. This is to be a Telford roadway, the base to be 8 inches, and the broken stone to be 6 inches, in thickness.

Boylston Street. — A contract for filling the Boylston-street extension, from Boylston road to Brookline avenue, about 2,070 feet in length, was awarded to J. O'Brien on December 1, 1894, at the rate of $0.62½ per cubic yard, measured in the bank. The order of laying out requires a gravel roadway with gravel sidewalks.

Commonwealth Avenue.

This avenue now extends under one name from the Public Garden to the Newton line, a total length of 5.59 miles, it having been extended from the Chestnut Hill Reservoir gate to the Newton line, where it connects with a new avenue bearing the same name, which, like the part in Boston, is only partially completed. This avenue extends through the heart of Newton, a farther distance of four miles.

Commonwealth avenue in Boston varies in width from 120 to 200 feet, and is laid out partly as a parkway, in the care of the Park Department, partly as a highway, with heavy teaming ruled off by order of the Board of Aldermen, and partly as an ordinary highway. It was formed of portions of streets formerly bearing different names, with widenings and extensions made at different times. The extension of the avenue from Beacon street has been under construction for the last eleven years, during which time about one million two hundred and seventy-five thousand dollars has been expended upon it. A large amount of work has been done upon every part of it, excepting the most recent

extension, and a large amount yet remains to be done to complete the enterprise.

The following is a short account of what has already been done, together with a statement of its present condition and an approximate estimate of the cost of completion:

Beginning at the Public Garden in Boston, the first section, extending to Beacon street, a distance of 1.44 miles, was taken by the Park Commissioners, under Chap. 300, Acts of 1893, as a parkway. This section is uniformly two hundred feet wide. The part of it between the Public Garden and Massachusetts avenue has two roadways and a central planting space. The northerly roadway is thirty-five feet wide between curbs; the southerly roadway is thirty-five feet between curbs; the central planting space is one hundred feet wide, with a gravel walk in the centre eighteen feet wide, and the sidewalks, each, fifteen feet wide. The roadways have been rebuilt this season in a thorough manner with Telford stone. The work was done by the Street Department for the Park Department. The excavation of the old surface was let in eight contracts. The stone for the Telford foundation was furnished by ten contractors and by the Street Department, and was set by four contractors. The old gutter blocks were removed by two contractors, and new ones were furnished by two contractors and from the city paving yards, and were set in place by four contractors. The edgestones were reset, where necessary, and the sidewalks repaved in part by two contractors. Broken stone for the macadam surface was furnished by two contractors, and from two city crushers. Steam-rollers were furnished from the Street and Park Departments and from contractors; the maximum number used was six. Gravel for gutter paving was furnished by the Street Department, and the broken stone was received and spread, and all miscellaneous work required to connect the various contracts was done, by the regular force of the Street Department. Platform scales were set up on the work, and all Telford and macadam materials were received by weight. The broken trap rock was weighed on cars.

Each roadway has two gutters, three feet in width. The Telford road has a base of Roxbury conglomerate eight and a half inches thick, thoroughly rolled, and a surface of broken stone four and a half inches thick after rolling. Between Arlington and Fairfield streets, the surface is trap rock from Salem and Waltham, furnished by the Massachusetts Broken Stone Company. From Fairfield to Gloucester street, on the northerly roadway, the surface is Roxbury conglomerate from Humboldt avenue, furnished by H. P. Nawn, and the

remaining blocks are surfaced with Roxbury conglomerate from the Tremont and Codman street ledges, mixed indiscriminately. No binding material, except stone screenings, was used, and on each section the screenings were of the same material as the broken stone. The intersections of cross streets were put in good order, and the street railways on Clarendon and Dartmouth streets were rebuilt with entirely new material, and Clarendon street was paved with granite blocks.

The total area of gutter paving was 7,446.7 sq. yds. The total weight of Telford base stone used was 11,806.64 tons, on 30,025.4 sq. yds., or 786.44 lbs. per sq. yd. The weight of trap rock macadam used was 7,467.36 tons, on 20,313 sq. yds., or 735.23 lbs. per sq. yd. The total weight of Roxbury stone macadam used was 4,211.08 tons on 11,842 sq. yds., or 711.21 lbs. per sq. yd. The result in weight of stone indicates that a considerably thicker road was actually built than was intended. The surface was kept at grade, and whatever settlement was caused by the weight of the heavy rollers was made good by additional broken stone.

The intersections of cross streets are built on a Telford base only in the continuation of the avenue roadways; the balance of the intersections were surfaced with broken stone and rolled. The quantity of broken stone used on them could not be exactly determined, and it was assumed that one-half the regular thickness was applied. The work was begun on July 30, 1894, and completed on November 20, 1894. The total cost of work on this section was $84,373.10, less $9,600 allowed for old materials removed; making the net cost $74,773.10.

The remainder of this section is irregularly laid out, and is connected with the Back Bay Fens.

The next section, from Beacon street to Cottage Farm bridge, is .79 mile in length and 160 feet in width; it is laid out in the following manner: Commencing on the southerly line sidewalk, 10 feet; planting space, 12 feet; roadway, 35 feet; grass and electric railroad, 33 feet; roadway, 45 feet; planting space, 10 feet; and sidewalk, 15 feet. The filling on this section by the Boston Contracting Company, and their successors, the Fidelity and Deposit Company, of Maryland, was completed on September 23, 1893. The total quantity of material delivered was 57,675 cubic yards, at $0.41 per yard, amounting to $23,646.75.

Telford stone was accumulated during the preceding winter, and the southerly roadway between Beacon street and Cottage Farm bridge was built during the year 1894 by the regular force of the Street Department. A fence and wooden

sidewalk on the southerly side was built by the carpenters of the Bridge Division of the Street Department: the gutters were paved by contract. The roadway is a Telford road, with a base ten inches thick, and six inches of Roxbury stone macadam. The northerly roadway was built in 1893 in the same manner, except that the macadam is trap rock. This section is practically completed to within three hundred feet of Cottage Farm bridge. The sewers, gas and water pipes, are laid in the side planting spaces.

The abutments of the bridge were built during the year. By arrangement with the Boston & Albany Railroad these abutments are built partly in the railroad location, and the part of the bridge which was formerly maintained by the railroad will hereafter be maintained by the city. The central abutment and the bridge have not yet been built.

Essex street connects with the widened avenue on the northerly side, so as to render considerable filling necessary to make even a temporary connection. The plan, as arranged by the Board of Survey, contemplates ultimately elevating Essex street and crossing the Grand Junction Railroad by a bridge: but it will be necessary to make a temporary grade of about 6 per cent. crossing the track at grade, in order to keep the street open until the Board of Survey plan is carried out.

Westerly from the bridge to Brighton avenue the section is 160 feet in width and the distance is .69 mile. For about 1,000 feet westerly from the bridge, through the marsh, there has been an excessive settlement of filling with a large displacement of mud: only one temporary roadway has been built here. An unexpected settlement took place at this point, requiring some 16,000 cubic yards of surplus filling, for which the contractor was paid an extra sum of money. The filling on this section was completed on August 9, 1894, and while it is probable that settlement will continue for some years, it is probable that a fair street surface can be maintained. There are no sewers, gas, water, or surface drain pipes laid in the "marsh section," except the large main water and gas pipes. The remainder of the section to Brighton avenue has one roadway completed. This is a Telford road of Roxbury stone of the same thickness as those east of the bridge, and was built by the Street Department in 1894. The remaining roadway (on the southerly side) has been built to sub-grade of gravel, with the intention of finishing it with gravel as a soft road suitable for fast driving.

The width, plan, and disposition of water, gas, and sewer pipes is the same as in the section east of the Cottage Farm bridge. A considerable amount of work on sidewalks, loam spaces, and fences remains to be done.

The section between Brighton avenue and Warren street is .88 mile long and 200 feet wide. It is laid out with three roadways, a saddle-path, three grass plots, and two sidewalks; the width of each and their order, commencing on the southerly side, as follows: Sidewalk, 10 feet; grass plot, 10 feet; roadway, 26 feet; grass plot, 29 feet; central roadway, 50 feet; saddle-path, 20 feet; grass plot, 9 feet; roadway, 26 feet; grass plot, 10 feet; sidewalk, 10 feet. The central roadway has been built and has been in use for several years. It was necessary to raise its grade for about 1,200 feet in length to fit the new grade adopted; the amount of this change in grade is from 0 to 1 foot, in vertical height. The sub-grading is completed on a large part of this section, and the construction of the two side roads has been commenced. The side roads are to be of lighter construction than in the preceding section, the depth being for Telford base 8 inches, for macadam, 4 inches. The sewer and surface drain work on this section is substantially finished, and there are nearly enough paving-blocks on the ground for the gutters. These blocks came from the section of the avenue taken by the Park Commissioners, with the understanding that $3,500 is to be paid for them when funds are available.

The section between Warren street and Chestnut Hill avenue is 200 feet wide and 1.07 miles long. This is an uneven and rocky section, with two sidewalks, 7.5 feet wide, and a roadway 50 feet wide winding irregularly through the location; it was built some years since. On September 15, 1884, in the Board of Aldermen, it was "Ordered, That the Board adopt the plan and profile for constructing Massachusetts avenue, in the Brighton District, as prepared by Henry M. Wightman, City Engineer, dated September 11, 1884, and deposited in the office of the said City Engineer, the said plan being a modification of a plan of said avenue designed by Frederick L. Olmsted. It being understood that the construction of said avenue shall be substantially in accordance with said plan. Passed."

The plan referred to has disappeared, but a copy exists. The road built does not exactly follow the plan, and no design has been adopted for the treatment of the remainder of the 200-feet location. A plan has recently been made which collects all the information concerning this section that is available, including the streets contemplated by

the Board of Survey, and the grades considered or adopted by them, and on this has been sketched a plan for building a series of side roads, and rough estimates have been made of the cost of completing the roads in accordance therewith. There will remain large areas of uneven land with high ledges between these roads, which, from their bold character, and the fine views from their summits, may be ornamentally treated, if desired. It would seem desirable that Mr. Olmsted should complete his design, and that this portion of the avenue should be built in accordance with it.

The remaining section between Chestnut Hill avenue and the Newton line is .72 mile long, and has been laid out as an ordinary highway. The plan provides for two roadways, three grass plots, and two sidewalks, disposed of as follows: Beginning at the southerly side: sidewalk, 10 feet; grass plot, 5 feet; roadway, 40 feet; grass and electric road, 25 feet; roadway, 25 feet; grass plot, 5 feet; sidewalk, 10 feet.

The estimated cost of completing the avenue from Beacon street to the Newton line, as outlined above, and exclusive of the cost of sewers and surface drains, and including land damages, is $556,598; or about $400,000, excluding the extension recently made beyond Chestnut Hill avenue, and provided that material is transferred from section to section. The estimates by sections are appended:

Estimated cost to complete the construction:	
Beacon street to Warren street . .	$188,405 00
Warren street to Chestnut Hill avenue .	164,157 00
Chestnut Hill avenue to Newton line .	99,685 40
Bridge at Cottage Farm, cost to complete,	60,159 00
Chestnut Hill avenue to Newton line, land damages, estimated by Street Commissioners	44,191 00
Total	$556,598 00

Fifteen per cent. for engineering and contingencies has been added in each section.

This estimate contemplates charging the section between Warren street and Chestnut Hill avenue with $22,920 for earth filling to be received from the section between Chestnut Hill avenue and the Newton line, and crediting the first-named section with $9,000 for rock to be used on the other sections.

Plans have been made showing the different methods of construction at different sections of the avenue, and also a

proposed method of completing the avenue from Warren street to Chestnut Hill avenue.

The following table shows the sums heretofore appropriated and expended upon the avenue:

DATE.	Appropriation.	Land Damages.	Construction and Miscellaneous.	Total Amount expended.
1883	$55,000 00	$24,800 00	.....	$24,800 00
1884	50,000 00	14,462 00	$49,992 03	64,454 03
1885	50,000 00	19,713 68	4,813 21	24,526 89
1886	40,000 00	.....	65,481 08	65,481 08
1887	125,000 00	14,000 00	9,932 70	23,932 70
1888	111,500 00	.....	46,069 45	46,069 45
1889	.....	40,366 98	49,070 24	89,437 22
1890	107,438 01	223,071 06	22,165 61	245,236 67
1891	.....	.....	.....	.....
1892	286,233 01	.....	123,170 81	123,170 81
1893	203,000 00	56,527 00	209,719 65	266,246 65
1894	247,000 00	30,275 00	271,349 47	301,624 47
	$1,275,171 05	$423,215 72	$846,313 34	$1,274,979 97
Balance	.....	.....	.....	$191 08

SIDEWALK PLANS.

A set of plans was made for the Street Department some years ago. The design was to show on one plan all pavements, gutters, sidewalks, street railways, and crossings, edgestones, all sewer and water pipes, and, in fact, all structures as they exist upon or under the surface of the public streets. The custody of these plans was turned over to this department in 1892, and a certain amount of work has been done each year toward bringing them up to date. The amount of work which the available force of the office can do each year is so small that most of the plans are hopelessly behind. They had not been recently corrected when they were turned over to us, and they are further behind now than they were then. Imperfect as they are, they are constantly consulted, and they can never perhaps be made absolutely

correct, as many streets in the older parts of the city contain structures of which there is no record. Under the present regulations it is possible to oblige all parties or corporations, having authority to use the public streets, to file plans of their structures, and it is a work of compilation to gather all the information into one plan of record. Until recently, it was necessary to gather most of this information from the street itself.

Unless means are provided by which more work can be done than is possible to do under the present conditions, the usefulness of these plans will diminish rapidly, and it will soon become a waste of effort to do anything upon them. An inspection of these plans has recently been made, and the following summary of their number and condition is given:

City Proper.

Of this division of the city there are 50 sectional plans, on a scale of 50 feet to an inch. The plans are nearly worn out, and as nothing has been done on them for many years, they are incomplete, and are incorrect in many particulars. These plans are used constantly. New plans should be made on a scale of 30 feet to an inch, similar to the Roxbury and Dorchester sectional plans. This would increase the number of plans from 50 to about 150.

Charlestown.

Of this division of the city there are 30 sectional plans, upon a scale of 30 feet to an inch. The set is incomplete, as 10 plans were either never made or have been lost. The plans are in good condition, so far as they go; but for several years nothing has been done upon them.

East Boston.

Of this division of the city there are 37 sectional plans, upon a scale of 40 feet to an inch. Seven plans have either never been made or have been lost, and there are no plans of Breed's Island. The plans are in good condition.

South Boston.

Of this division of the city there are 39 plans, upon a scale of 40 feet to an inch. Eleven plans required to complete the set have never been made. The plans are in good condition.

Roxbury.

Of this division of the city there are 79 plans, upon a scale of 40 feet to an inch. Two plans are missing, and 12 additional plans are required to complete the set. Twenty-five of these plans are very much worn and should be replaced. With the exception of the missing plans, this set is correct to January, 1895.

Dorchester.

Of this division of the city there should be 215 plans in the complete set. One hundred and six of the plans have been made, and are in good condition.

This district is growing rapidly; many new streets have been built since the plans were made, and many calls are made for the plans not yet made. These plans are upon a scale of 40 feet to an inch.

West Roxbury.

Of this division of the city there are 34 sectional plans, upon a scale of 40 feet to an inch. The plans are in good condition, but nothing has been done upon them for some years. About 300 plans would be required to complete the set, but as portions of this district are thinly settled, 100 additional plans would probably be sufficient for the next ten years.

Brighton.

Of this division of the city there are no sectional plans. There are 39 rolled plans, showing most of the principal streets, but nothing has been done upon these plans for many years. Sectional plans should be made of this district, the plans being made as needed. To make the complete set 120 plans would be required, upon a scale of 40 feet to an inch.

Summary.

The Roxbury set has been brought up to January, 1895, and some work has been done upon the South Boston and Dorchester sets. Each sheet, when corrected, is marked correct to the proper date in pencil. The remaining sheets have not been corrected for four years certainly, and it is unknown just when they were last corrected.

To maintain these plans in proper condition, a draughtsman and one assistant should be employed to take charge of them, to know all about them, to be responsible for their safe-keeping, to attend to people who desire to consult them, and to give their whole time to their correction. In one year, with the aid of such help as can be given by the remainder of the force in the winter, enough progress can be

made to determine what the cost of keeping up such a set of plans will be, and it should then be settled whether it is worth while to continue to do so or not. The pay of a draughtsman and assistant, competent to do this work, at present rates, need not exceed $1,600 per annum.

WIDTHS OF DRAW-OPENINGS.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in Appendix A. The openings have all been remeasured for this report.

Respectfully submitted,

WILLIAM JACKSON,
City Engineer.

CITY ENGINEERS.

1850–1894.

E. S. CHESBROUGH, M. Am. Soc. C. E.,
Nov. 18, 1850, to Oct., 1855.
(Died August 18, 1886.)

JAMES SLADE,
Oct. 1, 1855, to April 1, 1863.
(Died August 25, 1882.)

N. HENRY CRAFTS,
April 1, 1863, to Nov. 25, 1872.

JOSEPH P. DAVIS, M. Am. Soc. C. E.,
Nov. 25, 1872, to March 20, 1880.
(Resigned March 20, 1880.)

HENRY M. WIGHTMAN, M. Am. Soc. C. E.,
April 5, 1880, to April 3, 1885.
(Died April 3, 1885.)

WILLIAM JACKSON, M. Am. Soc. C. E.,
April 21, 1885, to the present time.

APPENDIX A.

Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1895.

Name of Bridges.	Location.	Number of Openings.	Width.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown	1	39	7
" " "	Over Miller's River	1	35	10
Broadway	Over Fort-point Channel	1	43	3
Cambridge-st.	Ward 25 to Cambridge	1	36	3
Canal	Boston to East Cambridge	1	36	1
Charles-river	Boston to Charlestown	1	36	0
Chelsea (South Channel)	Charlestown to Chelsea	1	38	9
" (North ")	" " "	1	44	10
Chelsea-st. (East Boston side)	East Boston to Chelsea	2		
" (Chelsea side)	" " "			
Commercial-point	Ward 24	1	24	0
Congress-st. (Boston side)	Over Fort-point Channel	2	43	3
" (So. Boston side)	" " "		43	11
Dover-st.	" " "	1	36	10
Eastern R.R.	Boston to Charlestown	1	39	8
" "	Over Miller's River	1	35	6
Essex-st.	Ward 25 to Cambridge	1	35	9
Federal-st.	Over Fort-point Channel	1	41	10
Fitchburg R.R.	Boston to Charlestown	1	36	0

Fitchburg R.R. (for teaming freight)			
Grand Junction R.R.			
Grand Junction R.R.			
Granite			
Harvard (Boston side)			
" (Cambridge side)			
L-street			
Lowell R.R. (freight)			
" " (passenger)			
Malden			
Meridian-st. (East Boston side)			
" (Chelsea side)			
Mt. Washington-ave. (Boston side)			
" " (So. Boston side)			
Neponset			
New York & New England R.R. (Boston side)			
" " " (So. Boston side)			
" " "			
North Beacon-st.			
North Harvard-st.			
Old Colony R.R.			
" "			
Prison-point			
Warren			
West Boston (Boston side)			
" (Cambridge side)			
Western-ave.			
"			
Boston to Charlestown	1	36	0
Ward 25 to Cambridge	1	35	9
East Boston to Chelsea	1	34	6
Ward 24 to Milton	1	36	0
Boston to Cambridge	2	36	6
" " "		36	8
Over Reserved Channel, South Boston	1	40	0
Boston to East Cambridge	1	40	2
" " " "	1	39	7
Charlestown to Everett	1	43	4
East Boston to Chelsea	2	59	2
" " "		59	0
Over Fort-point Channel	2	42	3
" " "		42	3
Ward 24 to Quincy	1	36	0
Over Fort-point Channel	2	41	10
" " "		40	11
Over South Bay	1	28	4
Ward 25 to Watertown	1	30	2
Ward 25 to Cambridge	1	36	0
Over Fort-point Channel	1	36	4
Ward 24 to Quincy	1	36	0
Charlestown to Cambridge	1	36	0
Boston to Charlestown	1	36	2
Boston to Cambridge	2	36	6
" " "		36	1
Ward 25 to Cambridge	1	36	0
Ward 25 to Watertown	1	35	10

APPENDIX B.

City of Boston, Revised Ordinances, 1892.

CHAPTER 12.

ENGINEERING DEPARTMENT.

SECTION 1. The engineering department shall be under the charge of the city engineer, who shall be consulted on all matters relating to public improvements of every kind where the advice of a civil engineer would be of service; shall, unless otherwise specially provided, take charge of the construction of all public works of the city which properly come under the direction of a civil engineer; shall, except as to sewers, perform all engineering services, and make all examinations and prepare all statements, plans, specifications, and contracts which any department may need in the discharge of its duties; shall, upon being notified by the superintendent of streets, supervise all repairs on the bridges of the city used as highways which affect the safety of the structures, and shall, when required by the mayor or by any officer or board in charge of a department, measure the work done by contract for the city, and certify to the result of such measurement.

SECT. 2. Said engineer shall in his annual report include a report of the safety and completeness of all ponds, basins, and reservoirs under the charge of the water-supply department, and of all bridges within the city limits used as highways.

APPENDIX C.

Engineering Department Property, Schedule Main Office.

1 horse.
2 carriages.
1 sleigh.
2 harnesses.
3 robes.
Instruments for drawing.
Instruments for surveying, as follows:
2 Temple transits.
5 Buff & Berger transits.
5 Gurley transits.
1 Stackpole transit.
3 Temple levels.
4 Buff and Berger levels.
5 Gurley levels.
11 Boston rods.
4 New York rods.
3 Troy rods.
Cases for plans and books.
Reference Library, 1,012 vols.
9,406 Plans Engineering Works, loose.
14 vols. Plans Engineering Works, bound.
Photographs of Engineering Works.
Apparatus for blue printing.
1 microscope.
1 mercurial barometer.
1 aneroid barometer.
1 holosteric barometer.
1 set hydrometers.
1 hygrometer.
1 pair field-glasses.
2 typewriters.
2 dynamometers.
1 pentagraph.
1 calculating-machine.
1 volt meter.
1 comptometer.

APPENDIX D.

Elevations referred to Boston city base. (The city base is 0.64 ft. below mean low tide.)

Feet.

0.00 City base.
15.66 Highest tide, April, 1851.
15.33 Coping of dry dock, Charlestown Navy Yard.
12.24 Greatest elevation of high tide per United States Tide Tables, August 22, 1895 (11.6+0.64)=12.24.
8.14 Least elevation of high tide per United States Tide Tables, February 19 and March 20, 1895 (7.5+0.64)=8.14.
2.64 Greatest elevation of low tide per United States Tide Tables, May 16, 1895 (2.0+0.64)=2.64.
—1.16 Least elevation of low tide per United States Tide Tables, October 19, 1895 (—1.8+0.64)= —1.16.
0.64 Mean low tide.
5.00 Piles cut off for building.
9.91 Water-works base (approx. tide marsh level).
9.82 South Boston base.
[1] — 4.98 Cambridge city case.
0.38 South Boston Flats base.

[1] Cambridge city base is 4.98 ft. below Boston city base.

APPENDIX E.

ENGINEERING DEPARTMENT ANNUAL REPORTS, 1867-1895.

No. of reports.	For the year.	Year published and No. City Document.	No. of reports.	For the year.	Year published and No. City Document.
First	1867	1868 — 22	Seventeenth	*1883	1884 — 55
Second and Third	1868-69	1870 — 14	Eighteenth	1884	1885 — 54
Fourth	1870	1871 — 15	Nineteenth	1885	1886 — 41
Fifth and Sixth	*1871-72	1873 — 23	Twentieth	*1886	1887 — 38
Seventh	*1873	1874 — 20	Twenty-first	1887	1888 — 39
Eighth	1874	1875 — 19	Special report	1888	1888 — 117
Ninth	1875	1876 — 24	Twenty-second	1888	1889 — 38
Tenth	*1876	1877 — 15	Twenty-third	1889	1890 — 39
Eleventh	1877	1878 — 20	Twenty-fourth	*1890	Executive Department Report, Document 1, Part I. 1891.
Twelfth	*1878	1879 — 22			
Thirteenth	*1879	1880 — 33	Twenty-fifth	1891	1892 — 11
Fourteenth	1880	1881 — 25	Twenty-sixth	1892	1893 — 10
Fifteenth	1881	1882 — 52	Twenty-seventh	1893	1894 — 10
Sixteenth	1882	1883 — 53	Twenty-eighth	1894	1895 — 10

*Out of print.

CONTENTS REPORT ENGINEERING DEPARTMENT FOR 1894.

[General index to contents Engineering Department Reports, 1867–1892, will be found in Report of February 1, 1892.]

B. — WATER-WORKS, *continued.*

ILLUSTRATIONS.

APPENDICES.